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U.S. Department of Transportation
Docket Operations, M-30
1200 New Jersey Avenue, SE
Room W12-140, West Building Ground Floor
Washington, DC 20590-0001

Re: ***Petition of Consumers Energy Company for an Exemption Pursuant to Section 333 of the FAA Modernization and Reform Act of 2012 to Operate an Unmanned Aircraft System***

Dear Sir or Madam:

Pursuant to Section 333 of the FAA Modernization and Reform Act of 2012 (the Reform Act) and 14 C.F.R. Part 11, Consumers Energy Company hereby applies for an exemption from the Federal Aviation Regulations identified below to allow for the commercial operation of the DJI S1000 with the A2 Flight Control System, manufactured by DJI Innovations (the S1000").

I. REGULATIONS FOR WHICH EXEMPTION IS REQUESTED

Consumers Energy Company requests exemption from the following regulations:

- 14 C.F.R Part 21, Subpart H;
- 14 C.F.R Part 27;
- 14 C.F.R § 45.23(b);
- 14 C.F.R. § 45.27(a);
- 14 C.F.R § 61.113;
- 14 C.F.R § 91.7(a);
- 14 C.F.R § 91.9(b)(2);
- 14 C.F.R § 91.9(c);
- 14 C.F.R § 91.103;
- 14 C.F.R § 91.109(a);
- 14 C.F.R § 91.119;
- 14 C.F.R § 91.121;
- 14 C.F.R § 91.151(a) & (b)

- 14 C.F.R § 91.203 (a) & (b);
- 14 C.F.R § 91.405(a);
- 14 C.F.R § 91.407(a)(l);
- 14 C.F.R § 91.409(a)(2);
- 14 C.F.R § 91.417 (a) & (b).

This petition incorporates the material contained in the Consumers Energy Company Operations, Inspection, and Maintenance Manual, the DJI S1000 User Manual, the A2 Flight Control System User Manual, the Consumers Energy Company S1000 Pilot Operating Handbook, and the Consumers Energy Company S1000 Training Manual (together, the "Manuals"). The Manuals are submitted herewith as confidential under 14 C.F.R. § 11.35(b), because they contain commercial and proprietary information that Consumers Energy Company has not and will not share with others, is not available to the public, and is protected from release under the Freedom of Information Act, 5 U.S.C. § 552 *et seq*.

II. STATUTORY AUTHORITY FOR REQUESTED EXEMPTIONS

This petition for exemption is submitted in accordance with Section 333 of the Reform Act. Congress has directed the FAA "to safely accelerate the integration of civil unmanned aircraft systems into the national airspace system." Pursuant to Section 333 of the Reform Act, the FAA Administrator is to permit operation of an unmanned aircraft system where it does not create a hazard to users of the national airspace system (NAS) or the public or pose a threat to national security based on the following considerations:

- The size, weight, speed and operational capability;
- Operation in proximity to airports and populated areas; and
- Operation within visual line of sight of the operator.

Furthermore, the Federal Aviation Act grants the FAA Administrator general authority to grant exemptions from the agency's safety regulations and minimum standards when the Administrator decides a requested exemption is in the public interest. *See* 49 U.S.C. §§ 106(f), 44701-44716, *et seq*. A party requesting an exemption must explain the reasons why the exemption: (1) would benefit the public as a whole, and (2) would not adversely affect safety or how it would provide a level of safety at least equal to the existing rules. 14 C.F.R. § 11.81.

III. DESCRIPTION OF CONSUMERS ENERGY COMPANY AND ITS SERVICES

Consumers Energy Company is a public utility that provides natural gas and electricity to more than 6 million Michigan residents. It is headquartered in Jackson, Michigan, and serves customers in 68 counties in Michigan's Lower Peninsula.

At present, Consumers Energy Company has seven power plants. Consumers Energy Company's largest power plant is the Karn-Weadock coal-fired generating station located on Saginaw Bay near Bay City. Other Consumers Energy Company coal-fired plants are the JH Campbell power plant between Holland and Grand Haven; the Cobb power plant in Muskegon and the Whiting Power Plant on Lake Erie in Luna Pier, just north of the Michigan/Ohio state line. Consumers Energy Company also operates and co-owns (with Detroit Edison) the Ludington Pumped Storage Power Plant near Ludington.

Two generating facilities previously owned by Consumers Energy Company (but still serving Consumers Energy Company's system) are the Palisades Nuclear Generating Station, 5 miles south of South Haven and The Midland Cogeneration Venture in Midland.

On the Muskegon River, in Newaygo and Mecosta counties, Consumers Energy Company operates 3 Hydroelectric Powerplant complexes. Together, the three dams (Rogers, Hardy and Croton) can generate about 45,500 kilowatts.

Consumers Energy Company has secured nearly 60,000 acres to develop wind generation farms in Mason and Tuscola counties. Consumer Energy's first wind farm began operations in 2013, and today the wind farms generate between 100 and 111 Megawatts of energy each. Development of wind power generation protects the Michigan environment and will bolster Michigan's economy. By combining renewable energy with efficiency measures and new, environmentally advanced large-scale electric generation, Consumers Energy Company is meeting the needs of its customers, the state economy, and the environment.

The contact information for the petitioner, Consumers Energy Company, is as follows:

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IV. DESCRIPTION OF PROPOSED OPERATIONS

Consumers Energy Company is requesting exemptions from applicable Federal Aviation Regulations (FARs) pursuant to Section 333 of the Reform Act to perform research and development using the DJI S1000 UAS. Key areas of focus for Consumers Energy Company's research and development are (i) public and worker safety; (ii) safe and timely power restoration following storms; and (iii) new methods to effectively inspect power lines, electrical facilities, vegetation and rights of way.

Consumers Energy Company is committed to improving power reliability for customers by more safely and quickly restoring power to customers after storm related damage to the electrical system. The Michigan Public Service Commission has emphasized to Consumers Energy Company the importance of reducing outage response time, a critical component of which is more accurate and timely storm damage assessment presently conducted by employees in motor vehicles or on foot. Use of the S1000 will help to reduce power restoration time and safety-related incidents involving employees working in adverse weather conditions.

Additionally, current inspections of high voltage (HVD) power lines are done one to two times a year by helicopter. Use of the S1000 will allow such inspections at considerable savings, as well as reduce safety risks because the drone will not carry a flammable fuel source. The S1000 will also allow better visual inspection of facilities installed on poles, as helicopter inspection of a utility pole usually involves less than 5 seconds of visual inspection.

Further, inspections of lower voltage power (LVD) lines are typically done by motor vehicle or on foot. Due to visibility limitations based on the design of utility poles, a certain portion of the pole and its facilities is never inspected. Using the S1000 to do LVD inspections will increase their effectiveness, decrease their safety risks, and reduce the time needed for the inspection cycle.

Thus, the research and development use proposed here will allow Consumers Energy Company to determine the efficacy of the S1000 for increasing public safety, restoring outages in a safe and timely manner, and creating new methods for inspecting electrical facilities.

The research and development use will take place on six Michigan research and development test sites (the R&D Sites) located in Jackson County, Tuscola County, and Mason County. The sites are owned by Consumers Energy Company and have low nearby residential populations. Two sites will focus on UAS research and development for power line monitoring; four sites will focus on UAS research and development for wind turbine

inspection. The satellite imagery of each site included below confirms that surrounding properties have few structures built on them. *See* Figures 1-7.

Research and Development Sites Chart

Site No.	Name	Location	Type of R&D
1	Cary Rd Sub	Columbia Township Jackson County Michigan	Power line monitoring
2	Lake Leann	Somerset Township Hillsdale County Michigan	Power line monitoring
3	Clear Lake	Grass Lake Township Jackson County Michigan	Power line monitoring
4	Crosswinds WTG-46	Columbia Township Tuscola County Michigan	Wind turbine inspection
5	Crosswinds WTG-28	Akron Township Tuscola County Michigan	Wind turbine inspection
6	Lake Winds WTG-8	Riverton Township Mason County Michigan	Wind turbine inspection
7	Lake Winds WTG-22	Riverton Township Mason County Michigan	Wind turbine inspection

Figure 1 – R&D Site Number 1: Cary Rd Sub

Figure 2 – R&D Site Number 2: Lake Leann Sub

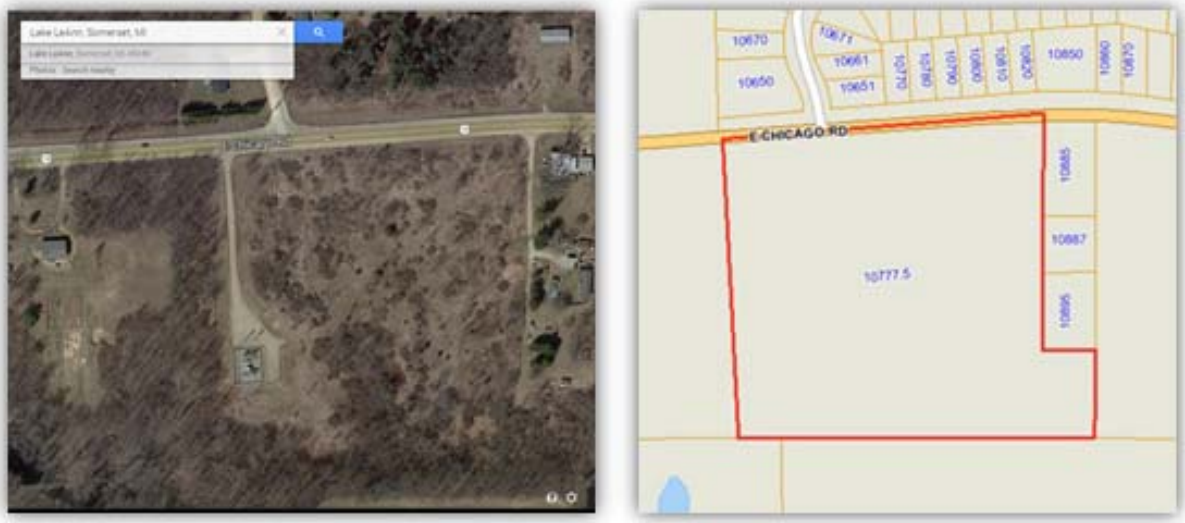


Figure 3 – R&D Site Number 3: Clear Lake Sub

Figure 4– R&D Site Number 3: Cross Winds WTG-46

Figure 5 – R&D Site Number 5: Cross Winds WTG-28

Figure 6 – R&D Site Number 6: Lake Winds WTG-8

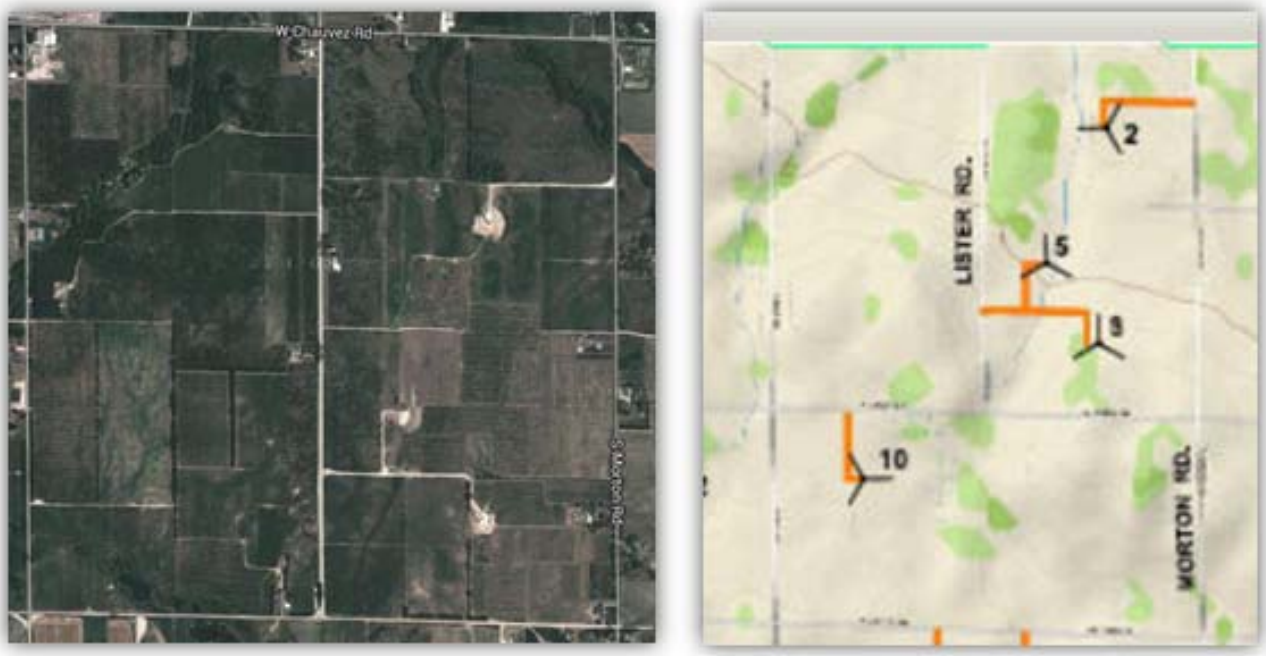


Figure 7 – R&D Site Number 7: Lake Winds WTG-22

A. The DJI S1000

Consumers Energy Company will operate the DJI S1000 with the A2 Flight Control System, manufactured by DJI Innovations (the "S1000"). The S1000 is a battery operated octocopter with a maximum flight time of 25 minutes. The vehicle weighs approximately 8.8 pounds with a maximum takeoff weight of approximately 24 pounds. It has retractable landing gear, vibration dampers, small frame air incline and minimalized gimbal mount, which allows for a 360 degree view from the camera. Although the vehicle's ground speed has a maximum of 45 mph, it will be operated between 5 and 15 miles per hour, and it will operate at or below 500 feet AGL.

The S1000 manufacturer's specifications are shown below in Figure 8. The S1000 is shown below in in Figure 9.

Figure 8 – DJI S1000 Specifications

Frame	
Diagonal Wheelbase	1045mm
Frame Arm Length	386mm
Frame Arm Weight (with Motor, ESC, Propeller)	325g
Center Frame Diameter	337.5mm
Center Frame Weight (with Landing Gear Mounting Base, Servos)	1330g
Landing Gear Size	460mm(Length)×511mm(Width)×305mm(Height) (Top width: 155 mm)
Motor	
Stator Size	41×14mm
kV	400rpm/V
Max Power	500W
Weight (with Cooling Fan)	158g
ESC	
Working Current	40A
Working Voltage	6S LiPo
Signal Frequency	30Hz - 450Hz
Drive PWM Frequency	8KHz
Weight (with Radiators)	35g
Foldable Propeller (1552/1552R)	
Material	High strength performance engineered plastics
Size	15×5.2inch
Weight	13g
Flight Parameters	
Takeoff Weight	6.0Kg ~ 11.0Kg
Total Weight	4.2Kg
Power Battery	LiPo (6S, 10000mAh~20000mAh, 15C(Min))
Max Power Consumption	4000W
Hovering Power Consumption	1500W (@9.5Kg Takeoff Weight)
Hovering Time	15min (@15000mAh& 9.5Kg Takeoff Weight)
Working Environment Temperature	-10 °C ~ +40 °C

Figure 9 – DJI S1000

B. The DJI A2 Flight Control System

The DJI S1000 will be used in conjunction with the A2 multi-rotor stabilization flight control system that provides self-leveling and altitude holding. The A2 is a complete flight control system for various multi-rotor platforms, including the S1000. The A2 provides precise positioning and flight control through its high performance antenna and low noise anti-interference front-end RF design. Notable features of the A2 Flight Control System include:

- **Auto Return-To Home/One Key Go-Home:** If the S1000 disconnects from the A2 during flight, the system's failsafe protection will enable the S1000 to return to home and land automatically. The operator can also setup a One Key Go Home function to activate this feature manually.

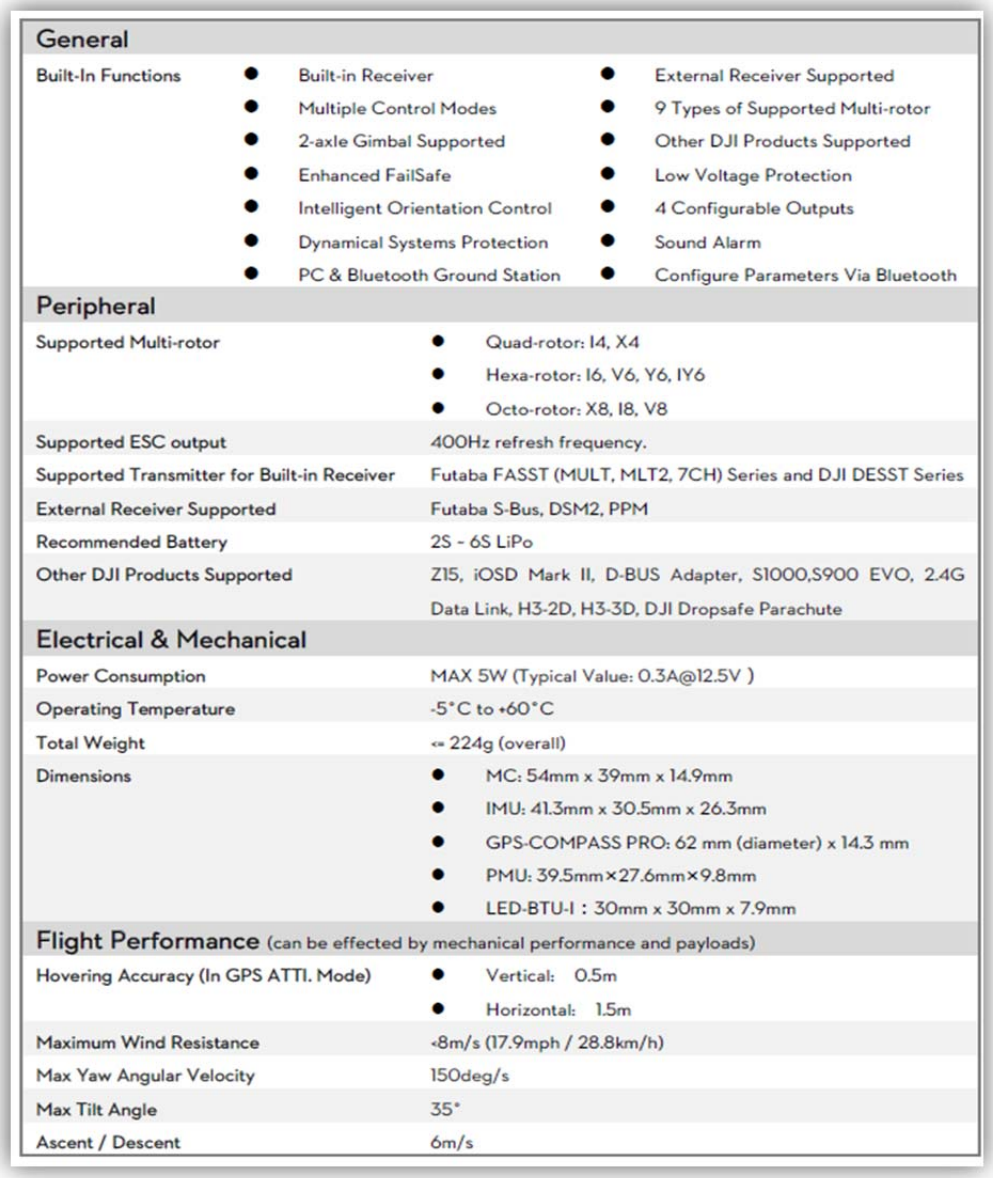
- **Multi-Rotor One-Motor Fail Protection:** When the S1000 is in attitude or GPS attitude mode, and one of the motors stops, the aircraft will retain good attitude and rotate around the frame arm with the stopped motor. In this condition, the S1000 is still under control and returns home safely, highly reducing the risk of a crash.

- **Set Speed Feature:** Ability to lock the S1000 craft into its current horizontal speed.

- **Point of Interest:** Users can record the current position of the S1000 as a point of interest by a preset switch on the remote control. The S1000 can achieve a circling flight around the point of interest with the nose pointing at the POI in an area of 5 meters to 500 meters radius, when the roll command is given. This function is easy to set and simple to operate, it is suitable for all-round shooting of a fixed scenic spot.

The A2's specifications are shown in Figure 10.

Figure 10 – A2's Specifications



General		
Built-In Functions	● Built-in Receiver	● External Receiver Supported
	● Multiple Control Modes	● 9 Types of Supported Multi-rotor
	● 2-axle Gimbal Supported	● Other DJI Products Supported
	● Enhanced FailSafe	● Low Voltage Protection
	● Intelligent Orientation Control	● 4 Configurable Outputs
	● Dynamical Systems Protection	● Sound Alarm
	● PC & Bluetooth Ground Station	● Configure Parameters Via Bluetooth
Peripheral		
Supported Multi-rotor	● Quad-rotor: I4, X4	
	● Hexa-rotor: I6, V6, Y6, IY6	
	● Octo-rotor: X8, I8, V8	
Supported ESC output	400Hz refresh frequency.	
Supported Transmitter for Built-in Receiver	Futaba FASST (MULT, MLT2, 7CH) Series and DJI DESST Series	
External Receiver Supported	Futaba S-Bus, DSM2, PPM	
Recommended Battery	2S - 6S LiPo	
Other DJI Products Supported	Z15, iOSD Mark II, D-BUS Adapter, S1000,S900 EVO, 2.4G Data Link, H3-2D, H3-3D, DJI Dropsafe Parachute	
Electrical & Mechanical		
Power Consumption	MAX 5W (Typical Value: 0.3A@12.5V)	
Operating Temperature	-5°C to +60°C	
Total Weight	≈ 224g (overall)	
Dimensions	● MC: 54mm x 39mm x 14.9mm	
	● IMU: 41.3mm x 30.5mm x 26.3mm	
	● GPS-COMPASS PRO: 62 mm (diameter) x 14.3 mm	
	● PMU: 39.5mm×27.6mm×9.8mm	
	● LED-BTU-I：30mm x 30mm x 7.9mm	
Flight Performance (can be effected by mechanical performance and payloads)		
Hovering Accuracy (In GPS ATTI. Mode)	● Vertical: 0.5m	
	● Horizontal: 1.5m	
Maximum Wind Resistance	≤8m/s (17.9mph / 28.8km/h)	
Max Yaw Angular Velocity	150deg/s	
Max Tilt Angle	35°	
Ascent / Descent	6m/s	

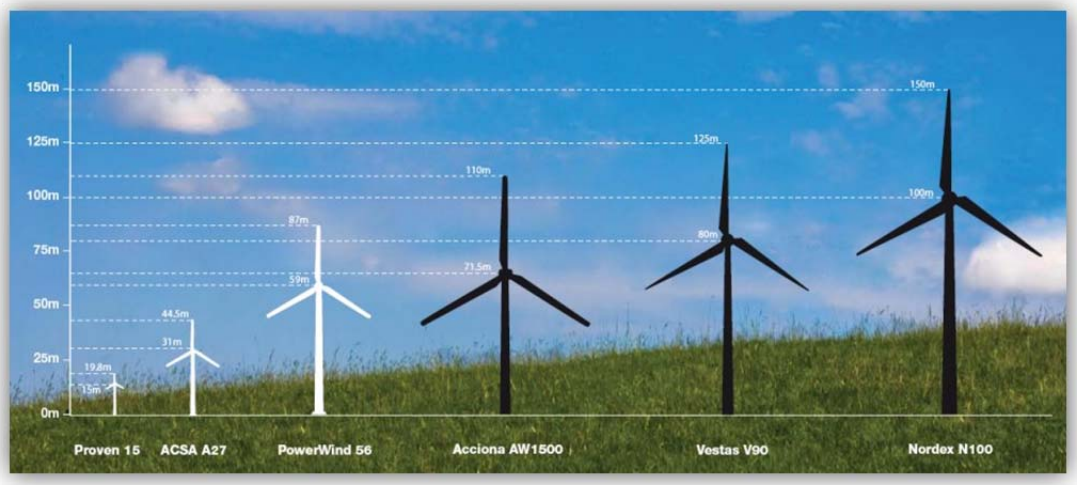
C. Consumer Energy Company's Proposed Operations Demonstrate an Equivalent Level of Safety

1. General Description of Proposed Flight Operations

Consumers Energy Company proposes to operate only on the R&D Sites and within the limitations and performance specifications listed in the Manuals, which are summarized below. These limitations provide for at least an equivalent, or higher, level of safety for operations under the current regulatory structure because the proposed operations represent a safety enhancement to the protocols currently used by Consumers Energy Company for power line and wind turbine monitoring. Moreover, the R&D Sites were specifically chosen as appropriate test grounds to determine the efficacy of using the S1000 on a wider scale.

The proposed operations do not create any hazard to users of the national airspace system or pose a threat to national security. The aircraft is a battery operated octocopter with a maximum flight time of 25 minutes. The vehicle weighs approximately 8.8 pounds with a maximum takeoff weight of approximately 24 pounds. It has retractable landing gear, vibration dampers, and small frame air incline. The vehicle's ground speed has a maximum of 45 mph but it will be operated between 5 and 15 miles per hour, and it will operate at or below 500 feet AGL. The requirement for clearance up to 500 feet AGL is necessitated by the size of the wind turbines on the R&D Sites, which can vary greatly in size and may reach as high as 150 meters, or 492.126 feet AGL, when the blades are positioned vertically. Figure 11, below, shows the varying sizes of exemplar wind turbines.

Figure 11: Wind Turbine Size



Manned aircraft are at risk of fuel spillage and fire in the event of an incident or accident. The S1000 carries no fuel, and therefore the risk of fire following an incident or accident due to fuel spillage is eliminated. Compared to manned aircraft, the unmanned aircraft being operated by the petitioner reduces the risk to participating persons in close proximity to the aircraft due to the limited size, weight, operating conditions, and design safety features of the S1000.

Consumers Energy Company's operations will be in remote areas at least 5 miles from any airport and away from population centers, as demonstrated by Figures 1-6 (the R&D Sites). The S1000 will be operated only on the R&D Sites, which are owned by Consumers Energy Company. Additionally, the wind turbine towers on R&D Sites 3-6 are already subject to obstruction marking, lighting and notification requirements set forth by the FAA.

The FAA has determined that the risk of not having an electronic means to monitor and communicate with other aircraft, such as transponders or sense and avoid technology, is mitigated by placing limits on altitude, requiring stand-off distance from clouds, permitting daytime operations only, and requiring that the aircraft be operated within visual line of sight and yield right of way to all other manned operations. Additionally, the operator will request a NOTAM prior to operations to alert other users of the NAS. *See* Exemption No. 11062, Docket No. FAA 2014-0352, at p. 13, attached hereto as Attachment 6.

The petitioner's aircraft has the capability to operate safely after experiencing certain in-flight failures, as specified above in the description of the A2 Flight Control System. The aircraft is also able to respond to a lost-link event with a pre-coordinated, predictable, automated flight maneuver.

2. Specific Limitations on Proposed Flight Operations

Given the small size involved, the restricted environment within which they will operate, the procedures listed below, and pilot certification requirements, Consumer Energy's proposed operations using the S1000 would "not create a hazard to users of the national airspace system or the public or pose a threat to national security." Reform Act Section 333(b)(1).

1. The aircraft is approximately 8.8 pounds.

2. The aircraft will be identified by serial number, registered with the FAA, and have identification (N-Number) markings as large as practicable.

3. Flights will be operated within visual line of sight of the pilot in command (PIC).

4. Prior to each flight, a zero altitude initiation point will be established and confirmed for accuracy by PIC.

5. Maximum flight time for each operational flight will be 20 minutes.

6. The aircraft will be safely landed with no less than the greater of (a) 20% battery life remaining or (b) five minutes of flight time remaining.

7. The aircraft will be operated during daylight and in VFR conditions.

8. Flights will not exceed 500 feet AGL, so as to accommodate inspections of wind turbines.

9. Flights will be operated at a lateral distance of at least 50 feet from any persons or property not associated with the operation who have not given prior permission.

10. Flights will be limited to a groundspeed of 45 mph.

11. Minimum crew for each flight will consist of a PIC and an Observer.

12. The PIC will possess at least a private pilot certificate, a third class medical certificate, and a designee from Consumers Energy Company will have completed a Factory Certified Basic Operator Course for the S1000.

13. Prior to the flight, a Mission Plan will be created setting forth the limitations for the flight as well as contact information for the PIC.

14. The flight operations will yield the right of way to other manned aircraft operations.

15. All persons who are not involved with Consumer Energy's operations will be required to be at least 500 feet from flight operations.

16. The aircraft will only operate within the R&D Sites.

17. Consumers Energy Company will provide NOTAM details to the FAA 24 hours prior to each flight.

18. All required permissions and permits will be obtained from territory, state, county or city jurisdictions prior to flight.

19. Prior to commencing operations, Consumers Energy Company will obtain a Certificate of Waiver or Authorization (COA) from the FAA.

20. If the aircraft loses communications, it will have the capability to return to a pre-determined location within the operational area and land.

21. If the aircraft loses its GPS signal it will have the capability of being flown manually to a predetermined location within the operational area and land.

22. The flight will be aborted in case of unpredicted obstacles or emergencies.

23. Each flight will be recorded in an Operations Log Book.

24. Maintenance on the aircraft will be recorded in a Maintenance Log Book.

3. Flight Recovery, Lost Communications, and Lost GPS Procedures

The flight recovery, lost communications, and lost GPS procedures are documented above, and are more fully documented in the attached A2 Flight Control System information and Consumers Energy Company Pilot Operating Handbook. (*See* Attachments 3 and 4).

4. Proposed Flight Areas

Consumers Energy Company is requesting to operate in the R&D Sites.

V. SPECIFIC FAR EXEMPTIONS REQUESTED

Consumers Energy Company seeks an exemption from several interrelated provisions of 14 C.F.R. Parts 21, 45, 61, and 91 for purposes of conducting the requested operations using the S1000. Listed below are (1) the specific FAR sections for which exemption is sought, and (2) the operating procedures and safeguards that Consumers Energy Company has established which will ensure a level of safety better than or equal to the rules from which exemption is sought. *See* 14 C.F.R. § 11.81 (e).

A. 14 C.F.R. Part 21, Subpart H – Airworthiness Certificates and 14 C.F.R. § 91.203(a)(1)

The FAA has stated that no exemption is needed from this section if a finding is made under the Reform Act that the UAS selected provides an equivalent level of safety when compared to aircraft normally used for the same application. These criteria are met, and therefore no exemption is needed. *See* Grant of Exemption to Astraeus Aerial, Docket No. FAA 2014-

0352 at 13-14, 22. If, however, the FAA determines that there are some characteristics of the S1000 that fail to meet the requirements of the Reform Act, an exemption is requested.

Equivalent Level of Safety: The S1000 is safe when taking into account its size, weight, speed, and operational capability. The S1000 weighs approximately 8.8 pounds and will be flown at speeds less than 45 miles per hour, in visual line of sight of the operator, and in remote and unpopulated airspace, specifically, on the R&D Sites. The S1000 does not carry pilots, passengers, explosive materials, or flammable liquid fuels. The S1000 will be operated within the parameters of the Manuals.

Consumers Energy Company will also provide the FAA with advance notice of all operations via NOTAM and coordination with the local FSDO. The proposed operations will be at least as safe as, or safer than, conventional rotorcraft operating with an airworthiness certificate without the restrictions and conditions proposed here. The proposed operations will also be as safe, or safer than, traditional power line monitoring and/or wind turbine inspection methods.

B. 14 C.F.R. Part 27 Airworthiness Standards: Normal Category Rotorcraft

14 C.F.R. Part 27 sets forth the procedural requirements for airworthiness certification of normal category rotorcraft. To the extent the S1000 would otherwise require certification under Part 27, Consumers Energy Company seeks an exemption from Part 27's airworthiness standards for the same reasons identified in the request for exemption from 14 C.F.R. Part 21, Subpart H.

C. 14 C.F.R. §§ 45.23(b), 45.27(a) and 91.9(c): Aircraft Marking and Identification Requirements

14 C.F.R. §45.23(b), Markings of the Aircraft states:

> When marks include only the Roman capital letter "N" and the registration number is displayed on limited, restricted or light-sport category aircraft or experimental or provisionally certificated aircraft, the operator must also display on that aircraft near each entrance to the cabin, cockpit, or pilot station, in letters not less than 2 inches nor more than 6 inches high, the words "limited," "restricted," "light-sport, "experimental," or "provisional," as applicable.

14 C.F.R. § 45.27(a) states:

> **Rotorcraft.** Each operator of a rotorcraft must display on that rotorcraft horizontally on both surfaces of the cabin, fuselage, boom, or tail the marks required by § 45.23.

14 C.F.R. § 91.9(c) states:

> No person may operate a U.S.-registered civil aircraft unless that aircraft is identified in accordance with part 45 of this chapter.

In a previous Grant of Exemption, the FAA determined that exemption from these requirements was warranted provided that the aircraft "have identification (N-Number) markings in accordance with 14 CFR part 45, Subpart C if the markings are "as large as practicable." *See* Exemption No. 11062, Docket No. FAA 2014-0352, at p. 14.

Equivalent Level of Safety: Consumers Energy Company will mark all S1000s with their N-Number in a prominent spot on the fuselage with markings that are as large as practicable.

D. 14 C.F.R. § 61.113: Private Pilot Privileges and Limitations

Consumers Energy Company seeks exemption from 14 CFR § 61.113, which restricts private pilots from flying aircraft for compensation or hire and would also require a second class medical certificate. The purpose of Part 61 is to ensure that the skill and competency of any PIC matches the airspace in which the PIC will be operating, as well as requiring certifications if the pilot is carrying passengers or cargo for hire.

While the S1000 will be operated as part of a commercial operation, it carries neither passengers nor cargo. In the Grant of Exemption in FAA Docket No. FAA-2014-0352, the FAA determined that the unique characteristics of UAS operation outside of controlled airspace did not warrant the additional cost and restrictions attendant with requiring the PIC to have a commercial pilot certificate and a class II medical certificate. The FAA has also determined that the required knowledge for a commercial pilot covers the same fundamental principles as a private pilot.

The PIC will possess at least a private pilot certificate, a third class medical certificate, and will have completed a DJI Factory-Certified Basic Operator Course for the S1000. This is a 3-day program that includes ground school and flight training. *See* the Consumers Energy Company S1000 Training Manual for more information on this Course. (Attachment 5.)

The FAA stated in its grant of an exception to Astraeus Aerial the "the FAA considers the overriding safety factor for the limited operations proposed by the petitioner to be the airmanship skills acquired through UAS-specific flight cycles, flight time, and specific make and model experience, culminating in verification through testing." See Exemption No. 11062, Docket No. FAA 2014-0352, at p. 18. The proposed operations can achieve an equivalent level of safety by requiring the knowledge and experience in S1000 operations described above.

Furthermore, the security screening conducted by the Transportation Security Administration of certificated airmen satisfies the statutory requirement of Section 333 for operations to not pose a threat to national security.

The restrictions Consumers Energy Company has placed on its S1000 operations meet or exceed the restrictions similarly imposed on Astraeus Aerial in FAA Docket No. FAA-2014-0352. Consumers Energy Company will operate in restricted areas (the R&D Sites) away from persons and property not involved in the operation. The aircraft will be flown based on VLOS at or below 500 feet AGL, so as to accommodate inspections of wind turbines on R&D Sites 3-6. A NOTAM will be issued at least 24 hours before the flight is to occur, and the flight will be coordinated with the applicable FSDO.

E. 14 C.F.R. § 91.7(a): Civil Aircraft Airworthiness

Consumers Energy Company seeks an exemption from 14 C.F.R. § 91.7(a), which requires that a civil aircraft be in airworthy condition to be operated. The FAA has stated that no exemption is required to the extent that the requirements of Part 21 are waived or found inapplicable. Accordingly, Consumers Energy Company requests that the requirements for Section 91.7 be treated in accordance with FAR Part 21 Subpart H. *See* Grant of Exemption No. 11062, p. 19.

F. 14 C.F.R. § 91.9(b)(2): Civil Aircraft Flight Manual in the Aircraft; 14 C.F.R. §§ 91.203(a) and (b): Carrying Civil Aircraft Certification and Registration

Pursuant to 14 C.F.R. § 91.9(b)(2):

> (b) No person may operate a U.S.-registered civil aircraft -
> …
>
> (2) For which an Airplane or Rotorcraft Flight Manual is required by § 21.5 of this chapter, unless there is available in the aircraft a current approved Airplane or Rotorcraft Flight Manual, approved manual material, markings, and placards, or any combination thereof.

Pursuant to 14 C.F.R. § 91.203(a) and (b):

> (a) Except as provided in § 91.715, no person may operate a civil aircraft unless it has within it the following:
>
> (1) An appropriate and current airworthiness certificate…

> (b) No person may operate a civil aircraft unless the airworthiness certificate required by paragraph (a) of this section or a special flight authorization issued under § 91.715 is displayed at the cabin or cockpit entrance so that it is legible to passengers or crew.

Consumers Energy Company does not request an exemption from this section but instead notifies the FAA that, in accordance with FAA Office of Chief Counsel's Opinion dated August 8, 2014, the UAS flight manual, registration certificate and other documentation will be kept at the control station with the PIC during flight. The Chief Counsel's Office has held that for all UAS operations, this alternate method constitutes full compliance with the regulations. *See also* Grant of Exemption No. 11062, pp. 19-20, and Grant of Exemption No. 8607.

G. 14 C.F.R. § 91.103: Preflight Action

Consumers Energy Company seeks an exemption from 14 C.F.R. § 91.103, which requires a PIC to become familiar with specific information before each flight, including information contained in the FAA-approved Flight Manual on board the aircraft. The aircraft will not have a Flight Manual on board. The PIC will take all actions including reviewing weather, flight battery requirements, landing and takeoff distances and aircraft performance data before initiation of flight. Under these circumstances, the FAA has stated that no exemption is required. *See* Grant of Exemption No. 11062, p. 20. An exemption is requested to the extent that an FAA-approved Flight Manual is required.

Equivalent Level of Safety: An equivalent level of safety will be provided by following the Manuals. The PIC will take all required preflight actions - including performing all required checklists and reviewing weather, flight requirements, battery charge, landing and takeoff distance, aircraft performance data, and contingency landing areas - before initiation of flight. The Manuals will be kept at the ground station with the operator at all times.

H. 14 C.F.R. § 91.109(a): Flight Instruction

Consumers Energy Company seeks an exemption from 14 C.F.R. § 91.109(a), which provides that "[n]o person may operate a civil aircraft (except a manned free balloon) that is being used for flight instruction unless that aircraft has fully functioning dual controls." UASs and remotely piloted aircraft, by their design, do not have functional dual controls. Instead, flight control is accomplished through the use of the A2 Flight Control System/Ground Control Station (GCS) that communicates with the aircraft via radio communications.

Equivalent Level of Safety: When flight instruction is performed, no pilots will be on the aircraft and the GCS will be a safe distance from the aircraft and the public, causing no

safety hazard. Given the size and speed of the S1000, an equivalent level of safe training can still be performed without dual controls because no pilot or passengers are aboard the aircraft, and all persons will be a safe distance away in the event that the aircraft experiences any difficulties during flight instruction. In addition, Consumers Energy Company will conduct flight training at a remote facility away from population centers. These training flights will be conducted on the R&D Sites and will otherwise comply with the provisions in the Manuals. Accordingly, Consumer Energy's proposed method of operation provides superior levels of safety.

I. 14 C.F.R. § 91.119(c): Minimum Safe Altitudes in Uncongested Areas

Consumers Energy Company requests an exemption from the minimum safe altitude requirements of 14 C.F.R. § 91.119(c). Section 91.119(c) prescribes that an aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure. The Manuals provide for operations away from congested populations areas on the R&D Sites, but in close proximity to wind turbines and towers on R&D Sites 306. The FAA has already determined that relief from Section 91.119(c) is warranted for UAS operations in uncongested areas with similar flight restrictions as those imposed by Consumers Energy Company. *See* Grant of Exemption No. 11062, p. 20-21.

Equivalent Level of Safety: Compared to flight operations with rotorcraft weighing far more than the maximum weights proposed herein, and given the lack of flammable fuel, any risk associated with these operations is far less than those that presently exist with conventional aircraft. An equivalent level of safety will be achieved given the size, weight, and speed of the S1000, as well as the locations where it is operated – the R&D Sites. In order to avoid any risk to aircraft, flight operations will be restricted to 500 feet AGL or below. Other aircraft are already prohibited from operating closer than 500 from the wind turbine structures where Consumers Energy Company proses to operate. This is airspace where other aircraft do not normally operate. As set forth in the Manuals and herein, the S1000 will be operated in the remote R&D Sites, away from persons or structures not involved in the operation. All persons who are not involved with Consumers Energy Company's operations will be required to be at least 500 feet from flight operations. This will pose no risk to the public because other aircraft are not operating in these areas.

J. 14 C.F.R. § 91.121: Altimeter Settings

This petition seeks an exemption from 14 C.F.R. § 91.121, which requires a person operating an aircraft to maintain cruising altitude or flight level by reference to an altimeter that is set to the elevation of the departure airport. The S1000 uses both barometric pressure sensors and GPS to determine altitude but does not have the ability to set in a current altimeter

setting. An exemption is required to the extent that the S1000 does not have a barometric altimeter setting. The altitude of the aircraft is monitored by the PIC on the ground control station and by the visual observer.

Equivalent Level of Safety: The FAA has stated that an equivalent level of safety can be achieved if the aircraft will be operated at or below 400 feet AGL and within visual line-of-sight in addition to GPS based altitude information relayed in real time to the operator. *See* Grant of Exemption No. 11062, p. 20-21. As the attached Manuals indicate, the S1000 will be operated at or below 500 feet AGL and otherwise complies with the limitations in the Grant of Exemption No. 11062.

K. 14 C.F.R. § 91.151(a): Fuel Requirements for Flight in VFR Conditions

Consumers Energy Company requests an exemption from 14 C.F.R. § 91.151(a)'s fuel requirements for flight in VFR conditions. Section 91.151 states:

> (a) No person may begin a flight in an airplane under VFR conditions unless (considering wind and forecast weather conditions) there is enough fuel to fly to the first point of intended landing and, assuming normal cruising speed -
>
> (1) During the day, to fly after that for at least 30 minutes; or
>
> (2) At night, to fly after that for at least 45 minutes.

Here, the technological limitations on S1000 battery power means that no meaningful flight operations can be conducted while still maintaining a 30 minute reserve. The aircraft is battery powered with a maximum flight time of 30 minutes. Consumers Energy Company proposes that the maximum flight time for each operational flight will be 25 minutes. The aircraft will be safely landed with no less than the greater of (a) 20% battery life remaining or (b) five minutes of flight time remaining.

Equivalent Level of Safety: The FAA has stated that an equivalent level of safety is provided if the UAS flight is conducted under daytime VFR flight conditions using VLOS, and terminated with at least 25% reserve battery power still available. *See* Grant of Exemption No. 11062, p. 21-22. The Manuals providing an equivalent level of safety by safely landing with no less than the greater of (a) 20% battery life remaining or (b) five minutes of flight time remaining and otherwise complying with the flight restrictions above.

L. 14 C.F.R. §§ 91.405(a), 91.407(a)(l), 91.409(a)(2); 91.417(a) and (b): Maintenance Inspections

Consumers Energy Company seeks an exemption from the maintenance inspection requirements contained in 14 C.F.R. § 91.405(a), 91.407(a)(l), 91.409(a)(2); 91.417(a) and (b). These regulations specify maintenance and inspection standards in reference to 14 C.F.R. Part 43. *See*, *e.g.*, 14 C.F.R. § 91.405(a) (stating that each owner or operator of an aircraft "[s]hall have the aircraft inspected as prescribed in subpart E of this part and shall between required inspections ... have discrepancies repaired as prescribed in part 43 of this chapter"). An exemption from these regulations is needed because Part 43 and these sections only apply to aircraft with an airworthiness certificate, which the S1000 will not have.

Equivalent Level of Safety: An equivalent level of safety will be achieved because maintenance and inspections will be performed in accordance with the Manuals. This includes maintenance, overhaul, replacement, and inspection requirements for the aircraft and procedures to document and maintain maintenance records for the aircraft. This also includes preflight inspection procedures. *See* Exemption No. 11062, Docket No. FAA 2014-0352, at p. 14-15.

As provided in the Manuals, flights will not be conducted unless a flight operations checklist is performed that includes all of the aircraft's components. The Manuals also set requirements for maintenance log books and record keeping as well as routine and post-flight maintenance. The Manuals set requirements for both annual maintenance and preventative maintenance.

VI. PUBLIC INTEREST

Granting Consumer Energy's petition for exemption furthers the public interest. National policy set by Congress favors early integration of UAS into the NAS in controlled, safe working environments such as the R&D Sites proposed in this petition. By granting this petition, the FAA will fulfill Congress's intent of allowing UAS to operate safely in the NAS before completion of the rulemaking required under Section 332 of the Reform Act.

Moreover, use of unmanned aircraft operations will improve power reliability for Consumer Energy's customers by reducing the time necessary to restore power after storm-related damage to the electrical system. The use of the S1000 will also decrease safety-related incidents involving employees working in adverse weather conditions.

Additionally, current inspections of high voltage (HVD) power lines are done one to two times a year by helicopter. Use of the S1000 will allow such inspections at considerable savings, as well as reduce safety risks because the drone will not carry a flammable fuel source. Drones will also allow better visual inspection of facilities installed on poles, as

helicopter inspection usually involves less than 5 seconds of visual inspection of a utility pole.

Further, inspections of lower voltage power (LVD) lines are typically done by motor vehicle or on foot. Due to visibility limitations based on the design of utility poles, a certain portion of the pole and its facilities is never inspected. Using the S1000 to do LVD inspections will increase their effectiveness, decrease their safety risks, and reduce the time needed for the inspection cycle.

Thus, the research and development use proposed here will allow Consumers Energy Company to determine the efficacy of the S1000 for increasing public safety, restoring outages in a safe and timely manner, and creating new methods enabling Consumer Energy's customers to save energy every day.

In addition, unmanned aircraft operations will replace the use of rope access or helicopters and small aircraft to monitor wind turbines. Traditionally, monitoring and inspection of the turbines involves an individual using either a manned aircraft or rope access to climb the large tower in order to visually inspect the turbine's blades for edge erosion, moisture intrusion, freeze/thaw cycling and lightning strikes, among other damage. Knowing the condition of the turbine's blades is essential to maximizing blade life. Thus, the inspections are intended to ensure that wind generation as a whole is both safe and reliable.

Yet performing this vital activity presents significant risk to the individual climbing the turbine or operating the manned aircraft in the vicinity of the turbines. For example, a 2011 newspaper article regarding wind- and solar-powered installations noted accidents involving wind turbines have tripled in the last decade. At least 78 wind-turbine related fatalities have occurred since the 1970s, with more expected as wind installations spread.[1] Use of an unmanned aircraft, like Consumers Energy Company's proposed use of the S1000 would significantly reduce the risk associated with turbine inspection.

The S1000 is approximately 8.8 pounds, carries no passengers or crew, has no flammable fuel, as opposed to larger and more powerful helicopters and small airplanes. The public has an interest in reducing the hazards and emissions associated with alternate use of helicopters and small airplanes to conduct similar inspection operations.

Additionally, Consumer Energy's intended uses for the S1000 have real-world benefits for the renewable energy industry and the public at large. Through the R&D Sites, Consumers

[1] "More Accidents Feared as Wind, Solar-Powered Installations Spread," 8/14/2011 Los Angeles Times article located online at http://www.toledoblade.com/Energy/2011/08/14/More-accidents-feared-as-wind-solar-power-installations-spread.html.

Energy Company may ultimately determine that it will be able to inspect and survey wind turbine blades and towers supporting the renewable energy industry. The use of the S1000 will also reduce the risks to human life associated with the traditional use of rope access for these operations. This program may prevent accidents and injuries, and there is a strong public interest in making these operations more safe and effective through the use of UASs.

VII. PRIVACY

All flights will occur over the R&D Sites, owned by Consumers Energy Company. All flights will be conducted in accordance with any federal, state or local laws regarding privacy.

VIII. SUMMARY FOR FEDERAL REGISTER

Pursuant to 14 C.F.R. Part 11, the following summary is provided for publication in the Federal Register, should it be determined that publication is needed:

Consumers Energy Company seeks an exemption from the following rules for the commercial operation of a small unmanned aerial system to inspect wind turbine blades and towers for the renewable energy industry: 14 C.F.R Part 21, Subpart H; 14 C.F.R Part 27; 14 C.F.R § 45.23(b); 14 C.F.R. § 45.27(a); 14 C.F.R § 61.113; 14 C.F.R § 91.7(a); 14 C.F.R § 91.9(b)(2); 14 C.F.R § 91.9(c); 14 C.F.R § 91.103; 14 C.F.R § 91.109(a); 14 C.F.R § 91.119; 14 C.F.R § 91.121; 14 C.F.R § 91.151(a) & (b) 14 C.F.R § 91.203 (a) & (b); 14 C.F.R § 91.405(a); 14 C.F.R § 91.407(a)(l); 14 C.F.R § 91.409(a)(2); 14 C.F.R § 91.417 (a) & (b).

The exemption will enhance safety by reducing risk to the operator, the general public and property owners from the substantial hazards associated with performing equivalent work using traditional rope access or using conventional aircraft and rotorcraft.

IX. ATTACHMENTS

Attachment 1: Consumers Energy Company Operations, Inspection, and Maintenance Manual

Attachment 2: DJI S1000 User Manual

Attachment 3: A2 Flight Control System User Manual

Attachment 4: Consumers Energy Company S1000 Pilot Operating Handbook

Attachment 5: Consumers Energy Company S1000 Training Manual

Attachment 6: Exemption No. 11062, Docket No. FAA 2014-0352

Attachments 2 and 3 are confidential documents submitted under 14 C.F.R. § 11.35(b) and are exempt from disclosure under the Freedom of Information Act, 5 U.S.C. § 552 et seq., and any other requirements established by the FAA pursuant to Section 333 of the Reform Act). If you have any questions or require any additional information, please do not hesitate to contact the undersigned attorneys for Consumers Energy Company.

X. CONCLUSION

Satisfaction of the criteria provided in Section 333 of the Reform Act - size, weight, speed, operating capabilities, proximity to airports and populated areas, operation within visual line of sight, and national security considerations - provides more than adequate justification for the grant of the requested exemptions to permit Consumers Energy Company to operate the S1000 on the R&D Sites.

Granting the requested exemption will benefit the public interest as a whole in many ways, including (1) significantly improving safety and reducing risk by alleviating human exposure to danger; (2) improving the quality of services Consumers Energy Company can provide to its customers; and (3) decreasing operating costs compared with traditional power line monitoring and wind turbine inspection.

Respectfully submitted,
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Attachment 1

DJI S1000

Operations, Inspection, and Maintenance Manual

Revision 1 December 16, 2014

I. FLIGHT OPERATIONS

A. Company Organization and Authority

1. Consumers Energy (CE) will conduct flight operations using an unamanned aircraft system (UAS) as described in this Operations, Inspection, and Maintenance Manual to conduct inspections of its electrical generating infrastructure.

2. CE will designate a Director of Flight Operations.

3. The Director of Flight Operations will ensure this Operations, Inspection, and Maintenance Manual is revised to contain all current information.

4. The Director of Flight Operations will ensure that this Operations, Inspection, and Maintenance Manual is distributed to all personnel involved with UAS operations as well as any revisions to this manual.

5. The Director of Flight Operations will ensure all pilots are trained according to Consumers Energy S1000 Training Manual and Consumers Energy S1000 Pilot Operating Handbook.

B. The Unmanned Aircraft System to be Used

1. Aircraft operations will be conducted using a DJI S1000 with the A2 Flight Control System, manufactured by DJI Innovations (the "S1000").

2. The aircraft will be identified by serial number, registered with the FAA, and have identification (N-Number) markings as large as practicable.

3. The aircraft weighs approximately 8.8 pounds with a maximum takeoff weight of approximately 24 pounds with a payload.

4. A complete description of the S1000 is contained in the DJI S1000 User Manual and the A2 Flight Control System User Manual.

5. Operation of the S1000 is described in Consumers Energy S1000 Pilot Operating Handbook.

C. Aircraft Registration, Log Book and CE Manuals

1. Each aircraft will have an Aircraft Log Book to record inspections, maintenance, and flight operations.

2. All required paperwork including Registration, Log Book, and CE Manuals will be located at the Ground Control Station in close proximity to the pilot in command.

D. Required Crew Members and Qualifications

1. Unmanned aircraft operations will require a minimum crew of a pilot in command (PIC) and a visual observer.

2. The PIC will possess at least a private pilot certificate, a third class medical certificate, and will be trained according to Consumers Energy Training Manual.

E. Training Requirements

1. Training requirements are described more fully Consumers Energy Training Manual.

F. Flight Areas

1. The aircraft will only operate within the operating areas defined as the R&D Sites in Consumers Energy's Petition for Exemption to the FAA.

2. Flight operations will not be conducted within 5 miles of an airport.

3. Flight operations will not be conducted over congested populated areas.

G. Weather Conditions

1. The aircraft will be operated during daylight and in VFR conditions.

2. The aircraft will not be operated if wind gusts are greater than 30 mph.

H. Flight Operation Parameters

1. Flights will be operated within visual line of sight of the pilot in command (PIC) or visual observer.

2. Prior to each flight, a zero altitude initiation point will be established and confirmed for accuracy by PIC.

3. Maximum flight time for each operational flight will be 30 minutes.

4. The aircraft will be safely landed with no less than the greater of (a) 20% battery life remaining or (b) five minutes of flight time remaining.

5. Flights will be operated at or below 500 feet AGL.

6. Flights will be operated at a lateral distance of at least 500 feet from any persons or property not associated with the operation who have not given prior permission.

7. Flights will be limited to a groundspeed of 25 mph and vertical ascent will be limited to 20 mph.

8. Prior to the flight, a Mission Plan will be created setting forth the limitations for the flight as well as contact information for the PIC.

9. The flight operations will yield the right of way to other manned aircraft operations.

10. All persons who are not involved with CE's UAS operations will be required to be at least 500 feet from flight operations.

11. CE will provide NOTAM details to the FAA 24 hours prior to each flight.

12. All required permissions and permits will be obtained from territory, state, county or city jurisdictions prior to flight.

13. Prior to commencing operations, CE will obtain a Certificate of Waiver or Authorization (COA) from the FAA.

14. Written or oral permission from the relevant property owners will be obtained prior to flight.

15. The flight will be aborted in case of unpredicted obstacles or emergencies.

16. Each flight will be recorded in the Aircraft Log Book.

I. Lost Communications Procedures

1. Flight recovery following lost communications will be performed according to the DJI S1000 User Manual, A2 Flight Control System User Manual, and the Consumer Energy Pilot Operating Handbook.

J. Lost GPS Procedures

1. Flight recovery following lost GPS signal will be performed according to the DJI S1000 User Manual, A2 Flight Control System User Manual, and the Consumer Energy Pilot Operating Handbook.

II. INSPECTION AND FUNCTIONAL TEST FLIGHT

A. Preflight Inspection Procedures

1. Before each flight, either the PIC or the visual observer will conduct a preflight inspection of the aircraft.

2. The aircraft and Ground Control Station will be inspected for signs of damage. Screws will be checked and tightened if necessary.

3. The Ground Control Station will be inspected ensure there are no broken or loose antenna connections, cracked casing, or broken or loose joysticks.

4. Aircraft propellers will be inspected to ensure they are not damaged, loosed, or misaligned.

5. Motors will be inspected to ensure the motors are not loose and the supports are not cracked.

6. Aircraft batteries will be checked that they are fully charged.

7. Ground Control Station batteries will be checked that they fully charged.

8. All batteries will be charged and maintained according to the S1000 User Manual.

9. A preflight maintenance inspection will be recorded in the aircraft log book.

B. Functional Test Flight

1. After a flight critical component, such as a propeller or motor, has undergone maintenance or been repaired or replaced, the aircraft must undergo a functional test flight.

2. The PIC will conduct the test flight in accordance with the DJI S1000 User Manual.

3. The PIC will make an entry in the aircraft log book of the functional test flight.

C. Postflight Inspection Procedures

1. After each flight, either the PIC or the visual observer will conduct a postflight inspection of the aircraft.

2. The aircraft and Ground Control Station will be inspected for signs of damage. Screws will be checked and tightened if necessary.

3. Aircraft propellers will be inspected to ensure they are not damaged, loosed, or misaligned.

4. Motors will be inspected to ensure the motors are not loose and the supports are not cracked.

5. Aircraft batteries will be charged.

6. Ground Control Station batteries will be charged.

7. All batteries will be charged and maintained according to the DJI S1000 User Manual.

III. MAINTENANCE

A. Aircraft Log Book

1. Each aircraft will have a log book to record inspections, maintenance, and flight operations.

B. Maintenance Procedures.

1. Each aircraft will be maintained using the maintenance procedures contained in the DJI S1000 User Manual, the A2 Flight Control System User Manual, and the Consumer Energy Pilot Operating Handbook.

2. All maintenance activity will be logged in the aircraft log book.

3. Batteries will be charged according to the procedures in the DJI S1000 User Manual, the A2 Flight Control System User Manual, and the Consumer Energy Pilot Operating Handbook.

C. Functional Test Flight

1. After a flight critical component, such as a propeller or motor, has undergone maintenance or been repaired or replaced, the aircraft must undergo a functional test flight.

2. Every 500 hours of flight time, the PIC will conduct a functional test flight regardless of maintenance activities.

3. The PIC will make an entry in the aircraft log book of the functional test flight.

Attachment 2

Submitted confidentially under 14 C.F.R § 11.35(b).
Exempt from disclosure under the Freedom of Information Act, 5 U.S.C § 552 *et seq.*

Attachment 3

Submitted confidentially under 14 C.F.R § 11.35(b).
Exempt from disclosure under the Freedom of Information Act, 5 U.S.C § 552 *et seq.*

Attachment 4

DJI S1000

Pilot Operating Handbook

Consumers Energy
PILOT OPERATION HANDBOOK
DJI S1000

KEY PARAMETERS

Max Takeoff Weight	24 lbs
Weight with Zenmuse and all other equipment – no camera, no battery	13.4 lbs
Weight of Nex5/6/7 camera	1 lb
Weight of Canon 5D camera	1.75 lbs
Max Battery Weight with Zenmuse/Nex Camera:	9.5 lbs
Max Battery Weight with Zenmuse/Canon 5D:	9 lbs

Flight Times using 90% of battery:

16,000 mah battery Nex 7:	17 min
20,000 mah battery Nex 7:	20 min
32,000 mah battery Nex 7:	22 min

Flight times using the Canon 5D or other cameras similar in weight will reduce the flight times by about 1 minute. These times are averages. An operator may get longer or shorter flight times based on weight and flying style.

DJI S-1000

CHECKLISTS

DJI S-1000 BENCH SET UP & TESTS

- All screws/bolts are tight
- Timer alarm for flight time to not exceed 80% battery capacity set properly
- Batteries are secure
- Antennas are secure
- Props balanced
- Props aligned
- Props not chipped
- Check blades, arms, etc. for cracks/damage
- Wiring Tight
- No excessive flexing of motors or booms
- Booms/motors will not twist
- Center of gravity is correct
- Warning lights set for low battery if used
- Batteries charged. Replace any battery which cycles below 80% of rated capacity
    - Laptop Battery
    - Flight Battery
    - Handheld Rx Battery
    - RC Tx Battery
    - Video Rx Battery
    - Spare Laptop Battery

DJI S-1000 INVENTORY CHECKLIST

- Load Flight plan
- Aircraft
- Camera with SD card
- Spare parts/tools
- Spare batteries
- Two RC transmitters
- Laptop
- Battery Charger
- Flight Controller Cable
- Video monitor, stand, battery, antennas
- Goggles
- Datalink & cable
- Battery Y-harness

DJI S-1000 PREFLIGHT CHECKLIST

- Determine emergency flight plan and alternate landing zones avoiding power lines and obstacles
- Check wind direction
- Set a perimeter of 50-100 meters – area must be clear of people
- All antennas installed and all pointing in correct directions
- Engage GCS, monitor, laptop, goggles, etc. (bring up flight plan)
- Remove lens cap / Clean lens
- Camera On
- Ensure camera has SD card installed.
- Check battery voltage
- Install battery on copter.
- Check CG
- Level copter with front pointing in correct direction for course lock – do not turn on
- On Copter TX - Set switches - Throttle Down, Return to Home switch Off, Manual Flight Mode
- Switch On, Flight Path Switch Off – Not Course or Home Lock
- Copter Transmitter On
- Check Model Selection on Tx
- Check Tx battery voltage (above 7.4v)
- On Photo Tx – set switches - HDMI switch Off, Freestyle switch On
- Photography Transmitter On
- Check Model Selection on Tx
- Check Tx battery voltage (above 7.4v)
- Plug in battery black lead first.
- Calibrate GPS/Compass if necessary
- If calibrated, cycle battery with correct heading for course lock.
- Do not touch the Copter until 30 seconds after full GPS Lock. Initial 3 red blinks is normal meaning no GPS lock. Wait until no flashes. Continue with checklist.
- Check Copter Voltage from GCS
- Engage Attitude Mode – Must Achieve Double Amber Flash
- Engage GPS Mode – Must Achieve Double Purple Flash
- While in GPS mode engage “Course Lock” mode. Must achieve green Flash

- Do not engage motors. Set throttle to center position. Must achieve single amber flash in Attitude Mode and single purple flash in GPS mode
- HDMI switch On (video on camera itself should go off)
- Freestyle switch On (FPV Off)
- Verify camera operation (If problems, check Drive Mode – Remote Cmdr must be “on”, manual focus, intelligent auto)
- Verify data link if installed – rolling copter manually should change gauges
- Upload flight plan
- Verify altitude is about 0 via gauge on computer/GCS/video monitor/goggles
- Timers set properly

TAKEOFF CHECKLIST

- Engage GPS mode – Double purple flash
- Engage Course Lock mode (double green flash)
- Announce loudly: “CLEAR PROP”
- Position the sticks in the lower left hand corners, then immediately raise the throttle 2 clicks, and center the right stick.
- Advance throttle to 1/4 power for 5 seconds. Assure all motors are operating.
- Verify that left/right and forward/back stick movement engages the proper motors
- Verify data and video links are still operational
- Announce loudly: “TAKING OFF”
- Advance throttle to full. Copter must jump off of the ground.
- Ascend to 3 meters. Center throttle stick. Should be single green flash. Verify wireless link, GPS hold, camera operation, gauges, etc. are working properly.
- Verify course lock is operational by rotating 90 degrees and pushing forward on stick.
- Verify copter stability. If unstable, land and reset gains, recalibrate, or retest as necessary.
- Raise landing gear
- Proceed with manual mission
- For autopilot operation
    - Ascend to 10 meters manually
    - Engage autopilot
- Manual pilot/observer must monitor the informational LED and be ready to take over in manual mode when necessary.
- Manual pilot to request copter flight battery voltage readout from camera operator periodically.

QUICK PREFLIGHT CHECKLIST

- Landing zone clear
- Level copter with correct heading
- Battery 4.1+ full, 3.8 depleted
- Camera on. SD card in.
- Both TX – all switches down
- Both TX on
- Copter on
- Check GPS and Course lock checks
- Video check
- Photo check
- Timers ready
- Takeoff
- Raise Landing Gear
- Unplug 6 batteries upon landing

ERROR MESSAGES

- White flashes
  - IMU malfunction. Land and determine cause. Possibilities:
    - GPS/Compass not pointing forward
    - IMU not pointing forward
    - Set up of X, Y, Z for location of IMU and Compass is incorrect
- Excessive rocking/instability possible causes:
  - Weak motor
  - Structure flexing from fatigue or cracks
    - Motor mount
    - Main frame
    - Booms
  - Loose Bolts causing flexing or misalignment
    - Props
    - Mounts
  - Props out of balance
  - Props misaligned
  - Excessive wind speeds or gusts
  - Excessive Gains
  - Excessive motor power. Max motor power must a little more than typical ascent power.
- Red Flashes (1, 2 or 3 flashes with pauses) – GPS loss (3 is more serious). Land if loss lasts for more than 30 seconds. Possible causes:
  - Clouds
  - Structures
  - GPS mal-function
  - GPS too close to electrical components
  - GPS vibration

LANDING CHECKLIST

- Landing area clear
- Lower landing gear
- Note obstacles in flightpath
- Announce loudly: “LANDING”
- First cut power to the aircraft
- Note elapsed time of flight
- Adjust any parameters (camera servo speed, exponential, etc)
- Turn power off to transmitters, camera, goggles, monitors, Rxs, etc.
- Touch motors to verify temperatures are similar
- Complete flight log
    - Date and time of flight
    - Batteries used
    - Time of Flight

TABLE OF CONTENTS

SECTION 1
GENERAL

NOTE: In an effort to minimize costs and maximize spare parts availability, many COTS (commercial off the shelf) components have been utilized. Some may have slight modifications to better suit this application. Most COTS products have separate data sheets, assembly manuals and instruction manuals. They are reference in this document, with key factors being emphasized.

As with all high technology products utilizing constantly evolving software, it is important to periodically check for online upgrades to the COTS components, including hardware, firmware and software.

WARNING: Great care must be taken with the batteries. Much of this manual and supplemental information is devoted to the use and care of the batteries, especially the flight batteries. They are less volatile than gasoline, though they should be treated with the same respect. Become very familiar with proper techniques of their use.

GENERAL CHARACTERISTICS

- Primarily for ISR (Intelligence, Surveillance, and Reconnaissance)
- Economical due to extensive use of COTS products
- Low Visual Signature
- Low Aural Signature
- Quick Launch and Recovery
- Short Training Period
- Simple Operation
- Waypoint Navigation
- Backpackable
- VTOL
- Quick Repairs
- Redundant Flight Systems
- Safety Return to Home during lost link or low battery
- High Degree of Mission Success
- GPS navigation aid
- Various sensors
- 24 lb max takeoff weight
- Operating Temp Range: -5°C to +60°C
- Flight Modes: Manual and GPS aided waypoint navigation

- Maximum Operating Altitude: 1000 meters
- Maximum Operation Wind Conditions: 10 m/s
- Propulsion System: LiPoly batteries
- Takeoff: Manual or Automatic
- Landing: Manual or Automatic
- Takeoff/Recovery Area: 5m square

IMPORTANT DIMENSIONS

- Distance rotor to rotor across the center: 41”
- Height with GPS/Compass folded down: 21”
- Height with GPS/Compass up: 25”
- Length of landing gear skids: 18”
- Distance between landing gear skids: 21”

IMPORTANT WEIGHTS

- Weight including Nex 7 camera, Zenmuse gimbal, A2 autopilot system, landing gear, data transceiver, RC transceiver, video transmitter, regulators and all wiring – everything except battery: 13.4 lbs
- Maximum Takeoff Weight: 24 lbs
- Battery Weight: up to 9.5 lbs with Nex camera and Zenmuse Gimbal

MOTORS

- Manufacturer: DJI-Innovations
- Number of motors: 8
- Motor type: 41mm x 14mm
- Motor Model Number: 4114-11
- Motor KV/RPM: 400
- Motor max @ 25.2V: 10,000 rpm
- Motor Max Power: 500 Watts
- Power rating: 4000 Watts maximum power consumption for all 8 motors
- Current Max: 100 amps
- Amp Draw Typical Average: 65 amps

PROPELLERS

- Manufacturer: DJI-Innovations
- Material: Composite
- Number of propellers: 8
- Propeller model number: DJI 15 x 5.2
- Number of blades: 2 - folding
- Propeller Diameter: 15”
- Propeller Pitch (fixed): 5.2”
- Max rpm: 10,000 rpm

ELECTRONIC SPEED CONTROLS

- Manufacturer: DJI-Innovations
- Number of speed controls: 8
- Speed control model number: DJI 40A Opto
- Rating in amps: 40 Amps continuous
- Signal Frequency: 30 - 450 Hz
- Drive PWM Frequency: 8 KHz

AUTOPILOT

- Manufacturer: DJI-Innovations
- Autopilot Model Number: DJI A2
- Components: GPS/Compass, IMU, Master Controller, Power Distribution System, LED Indicator Lighting System, Data Transceiver, GCS Software
- Power Consumption: 5W
- Operating Temp Range: -5°C to +60°C
- Software Compatible: Windows XP sp3 / Windows 7
- Hovering Accuracy: Vertical : ± 0.5m; Horizontal: ± 2m

WIRELESS LINKS

- Distributor: DJI-Innovations
- Frequencies:
  - 2.4 Ghz datalink with WiFi
  - 2.4 Ghz Command & Control
  - 5.8 Ghz Video
- Power Consumption: 1 watt
- Usable Range: Less than 2 km.

FUEL/FLIGHT BATTERY

- Manufacturers: Various COTS suppliers
- Battery chemistry recommended: Lithium Polymer
- Battery Capacity: 16,000 - 42,000 mah
- Battery cell count required: 6S (6 cells in series)
- Battery Voltage: 21 V minimum during hover, 22.2V nominal, 25.2V maximum
- Battery Minimum Rated Discharge Rate: 20C minimum
- Battery Minimum Charge Rate: 1C (3C preferable)
- Battery Rest Time between discharging and charging: 0-30 minutes
- Batteries used simultaneously: 1-4
- Recommended Battery Discharge Amount: 80-90%

FLIGHT PARAMETERS

- Flight Time: up to 30 minutes
- Payload Max: 11 lbs
- Power Consumption in a Hover at 21 lb takeoff weight: 1500 Watts, 65 amps

WARNINGS

- Never power a video transmitter or receiver without an antenna connected or overload failure will occur.
- Read all information regarding batteries contained in this manual and supplements.
- Batteries are highly flammable and can explode, especially when fully charged. Improper charging, vibration, impact, high discharge, etc. can lead to explosion and fire. Batteries must be charged under constant supervision and using proper precautions.
- Batteries fully charged must be handled with extreme care.
- Batteries must not be stored above 50% charged state.
- Store batteries between 20% - 50% charged state. Fully charge just before use.
- Fully charged batteries which are not to be used within 24 hours should be discharged to 20% - 50% charged state.
- Discharging LiPoly batteries in excess of 80% of their rated capacity can cause harm to the batteries.
- Using more than one battery at a time requires the proper wiring harness so that the voltage is no more than 25.2V. Over voltage will cause serious damage to electrical equipment.
- Using more than one battery at a time requires weight and balance checks. Proper CG is critical to performance. Airframe must not be overloaded.
- Propellers must be balanced to avoid excessive vibration.
- GPS/Compass must be facing forward.
- Do not use GPS Mode without GPS lock.
- Use low strength thread locking compound on all screws.
- Wireless Video and Data ranges vary considerably on many factors including weather, equipment, and obstructions. Be prepared for com failures.

SECTION 2
LIMITATIONS

AIRSPEED LIMITATIONS

- Vne – Velocity to Never Exceed: 15 m/s
- Va – Typical Maneuvering Speed – 5 m/s

POWER & POWERPLANT LIMITATIONS

- 40 Amps max per motor
- 40 Amps max per speed control
- 320 Amps max total
- Do not exceed 80-90% discharge of rated battery capacity
- Do not charge batteries which are warmer than air temperature
- Allow batteries to cool after use before charging
- Leave an air gap between batteries when multiple batteries are used simultaneously

WEIGHT LIMITS

- Takeoff Weight Max: 24 lbs
    - Must be checked prior to takeoff if any change in equipment is made

CENTER OF GRAVITY LIMITS

- 3mm from the center of any of the three pairs of arms
    - Must be checked before every flight to ensure batteries were installed in the proper location.
    - Check all 4 pairs of arms before flight

MANEUVER LIMITS

- This aircraft is intended for non-aerobatic operations
- G-loading maximum: 2G

TEMPERATURE LIMITS

- Operating Temp Range: -10°C to +40°C
- In cold temperatures
  - Keep IMU at room temperature if possible before the flight
  - Keep Batteries above 5°C before flight
  - Do not fly with any frost or ice on the propellers
- In warm temperatures
  - Batteries heat up when discharged
  - The higher the discharge rate the higher the temperature increase during use
  - At temperatures above 45°C, use of 2 or more batteries is required to lower the load on any one battery pack to keep it cooler.

WEATHER LIMITS

- Light dust and light rain require the use of a shield for the electronics in the center section.
- Light dust and light rain are acceptable for the unshielded motor and ESC.

RANGE LIMITS

- FUEL
  - Fuel capacity is a primary limiting factor.
  - Flying into the wind will use more battery power to travel the same ground distance. Higher air speeds will be required to penetrate the wind which used more battery power. Take this into account when flying a mission.
  - Where possible, fly upwind at the start of a mission and downwind at the end to avoid depleting the battery before returning to base. Have alternative landing sites available in case of emergency landing.
- WIRELESS LINK
  - Wireless links will be stable in LOS (line of sight) in most conditions
  - Wireless links are always susceptible to shorter ranges due to
    - Atmospheric conditions
    - Other transmission devices in the area
    - Jamming
    - Antennas not aligned properly

- Improper voltage
- Antenna blockage from AV in certain positions
- Multipath – reflection off buildings or ground which cause multiple signals to arrive at different times and/or phase.

SECTION 3
EMERGENCY PROCEDURES

MOTOR FAILURE

- Operation is possible with one motor/ESC/propeller failure
  - The two adjacent motors/ESCs will be increased in thrust automatically by the flight controller to overcome the loss
  - In cases where the airframe is highly loaded the maximum rating of 40 amps may be exceeded by these two motors/ESCs
  - Operation should be terminated as soon as possible to reduce the possibility of damage to the remaining motors

COMMUNICATION FAILURE

- Video link failure
  - 5.8 Ghz being the shortest wavelength in general AV use has the least ability to penetrate. This link should be the first to be lost.
  - It is best to lose video first! It is the least likely to cause a crash when it fails. 5.8 Ghz can lose link with little warning.
  - Ensure that the GCS station antennas are perpendicular to the AV. Do not point the antenna at the AV.
  - Yaw the AV to change the antenna position
  - Other links should still be good. Return back to the GCS until link is restored. Transmitters produce heat when in operation. When overheated they may have thermal protection which interrupts use temporarily. Use of a heat sink or fan may be required especially with high ambient temperatures.
  - Higher gain antennas may be used, but do so with caution. High gain antennas are directional.
  - Multiple antennas using “diversity” can be used. Diversity is a device which determines the best signal, and uses that.
  - 5.8 Ghz even at high wattages theoretically has less range than lower frequencies. Changing to 1.3 Ghz is an option, though there are other issues to be considered.
- RC link failure
  - 2.4 Ghz antennas can lose link with little warning.
  - Anything in between the two antennas can cause temporary signal loss especially a person.

- Hold the transmitter up in the air and walk in the general direction of the AV (aerial vehicle).
- Ensure that the antenna is vertical. Do not point the antenna at the AV.
- The failsafes on the RC link should be set so that the AV returns to home. Should this require a heading change, the antenna may move into a more desirable position and link will be restored.
- The onboard equipment may block the signal. Yaw the AV so that the antennas point towards the GCS.
- A LRS (long range system) can be used as a permanent solution. This is higher in wattage and usually on 433 Mhz.

Data Link Failure

- 900 Mhz do not lose link without some warning. When drop outs are noticed to increase in frequency that is the limit of the range.
- If using 900 Mhz, this is on cell phone frequency. If a cell tower is nearby it can swamp the signal. 900 Mhz may not be usable in that area. Change to a different freq. or remain closer to the AV

LOW BATTERY POWER

- Fail-safes can be set such that in the event of low battery power, either due to a failure or too long of a flight, the warning light on the AV will constantly flash amber. This is the first level of warning.
- The second warning level is red flashing lights
- Auto landing will occur when battery power is low. It may land in a tree or a lake, so this is not desirable.
- Landing with 80-90% of battery depleted is best. Therefore landing with 17,000 mah used and 3,000 mah remaining of a 20,000 mah battery is desirable. Batteries should be drawn down equally when in use if they are both charged equally and both in relatively the same condition/age.
- Do not mix partially charged batteries. Only use completely charged batteries.
- Over discharging a battery below 19.8V can permanently damage the battery.

GCS FAILURE

- Takeover by the external pilot should happen ASAP using the RC link.
- Most often happens due to a low battery.
- Keep a spare 3 cell LiPoly battery with the appropriate plug to plug into the charge jack for emergency use. Most chargers are 19V output which is roughly equivalent to a 4-cell battery. 3-cell batteries may work.

COMPASS CALIBRATION ERROR

- If the compass is out of calibration the warning light will flash red. This is the same signal as low voltage. If the voltage is correct, there is a calibration error.
- Recalibrate the compass following the instruction manual

FIRE

- Fires can occur due to a short circuit or battery failure.
- Disconnect the battery ASAP unless there is danger in doing so if there is any electrical issue.
- It is not possible to put out a battery fire.
- Do not attempt to put out a battery fire. Use a fire extinguisher to put out fires surrounding the battery. A CO2 fire extinguisher is better than the powder or chemical type. CO2 does not leave a residue. Water can be used though it may cause other electrical component failures.

FORCED LANDINGS

- If alternate emergency landing zones should be chosen ahead of time.
- Be sure that the LZ is clear of people to avoid any incidents.
- Land in the nearest LZ which is clear of people.
- Announce your intentions of landing as loud as necessary to alert people of the incoming AV.

SECTION 4
SET UP SUGGESTIONS

ELECTRONICS BURN IN

- We recommend that you put weights onto the landing skids to keep the copter on the ground and run the copter at about 70% throttle for about 2 hours to burn in the electronics. Most electronic failures occur in the first 2 hours of operation.

GPS/COMPASS MAST LENGTH

- We found that the higher the mast, the better the GPS reception

Nex5N vs. Nex7 vs. Canon 5D vs. Panasonic GH3

- These cameras are excellent for stills, and very good for video. The best for video is the Panasonic GH4 with 4k capabilities.
- We found that the Nex 5N takes exceptional quality stills and video, though most professionals use the Nex 7. The Canon 5D is better than the Nex7 due to its larger sensor.
- Use the Panasonic GH4 if you primarily shoot video

RADIO SET UP

- Follow the instructions in the manual
- We prefer the switch assignment as shown in the checklists above though feel free to modify to your liking

COPTER COMMAND AND CONTROL

- We recommend the use of a dual rate switch for main copter operation.
    - High rate – used to initialize the motors. The flight controller will not engage unless it sees full down throttle, full left rudder, full left cyclic and full back cyclic. However, these may be too high for normal flying. On high rate it is helpful to utilize fairly high exponential to make the stick feel soft around center. Adjust to your preference.
    - Low rate – used for typical flying. Set the end point adjustments such that full stick deflection offers the maximum speed required in normal flying. If conditions require higher flight speeds, switch to high rate. On low rate it is also helpful to utilize a small amount of exponential to make the stick feel soft around center. Adjust to your preference.

ZENMUSE COMMAND AND CONTROL

- We recommend the use of a dual rate switch for gimbal operation.
  - High rate – used to initialize the gimbal. The gimbal may not engage unless it sees full motion. However, these may be too high for shooting video smoothly. This is best for still photography so as to put the camera on target quickly. On high rate it is helpful to utilize fairly high exponential to make the stick feel soft around center. Adjust to your preference.
  - Low rate – used for videography. Set the end point adjustments such that full stick deflection offers the maximum speed required for videography. If conditions require higher gimbal speeds, switch to high rate. On low rate it is also helpful to utilize a small amount of exponential to make the stick feel soft around center. Adjust to your preference.

TIMERS

- Use of the countdown timer is a good backup method to ensure landing with battery power.
  - Set the timer for 20 minutes (or what you deem appropriate) and have it start when the throttle is over 1/4. Then adjust the timer upwards until the amount of battery used is about 80-90% of the total available. If using 20,000 mah batteries, a total of 17,000 mah would be the target. Set the timer such that you have a minute or so to land after the alarm sounds so that you have adequate time to return to base. Adjust to your preference.

BATTERIES

- Replace the transmitter standard battery with a Lipoly battery to extend use times to 8 hours. Supplied batteries often last about 2 hours.

NORMAL PROCEDURES

PREFLIGHT CHECKLIST

- Confirm all communication radios are operational
  - Radios with others in the group
- Set a perimeter of 100 meters
  - Area must be clear of people to avoid collision
- Check for overhead power lines and other obstacles to avoid
- Check structural integrity
  - In event of prior crash, inspect all booms, props and motor mounts for excessive flex indicating structural fatigue/failure
- Have a manual flight plan avoiding obstacles.
- Load auto flight plan if using one
  - Be sure that the total flight time is under 10 minutes to avoid low battery
- Clean lens
  - Remove lens cap
- Ensure camera has SD card installed
  - Many flights have been wasted due to this!
- Install batteries
  - Ensure that the straps are tight and the Velcro keeps the batteries from moving which will avoid a shift in the CG (Center of Gravity – or that it balances evenly)
- Check CG (Center of Gravity)
  - Lift the copter on each of the 3 pairs of arms. The copter should balance properly. If not, do not fly. Rearrange the equipment such that the CG is
- IMU pointing forward
  - The Inertial Measurement Unit is set so that it must face forward
- GPS/Compass installed, limited free play, pointing forward
  - This device must be installed with a screw to hold it in place. It cannot vibrate easily. If it does not point forward, the corrections in ATTI and GPS mode will be incorrect and it will crash. The FC will provide a warning with constant flashing white lights.
- Level copter using a bubble level with front pointing in correct direction for course lock – do not turn on
  - Keep in mind the best angle for pointing the landing gear in the direction that will keep the landing gear out of the shot when flying.

- Turn on Pilot Tx
- If using the rate gyro, set it at the correct position. This is usually a slider switch. Gains should have the range set from 200 – 350. Use the highest gain possible which does not cause oscillation.
- Check Model Selection on Tx to be S800
- Throttle on Tx Down
- Return to Home switch Off
- Adjust gain to correct position (if required)
- Manual Flight Mode Switch to manual (not ATTI or GPS mode)
- Flight Path Switch Off – Not Course or Home or POI
- Check Tx battery voltage (above 7.5v)
    - These settings above are required to initialize the copter properly. If the switches are in the incorrect position, it will not initialize properly which may cause some of the functions like course lock or GPS mode to not operate properly.
    - If the copter does not function properly after takeoff, land immediately and disconnect the copter power. Then put all the switches in the proper position for initialization and turn the power back on to the copter.
- Count down timer should be set to 20 minutes. This can be adjusted to your flying style. The timer should engage at 1/4 throttle and trigger an alarm at the proper time. This is a backup alarm in case the indicator lights on the copter are not visible.
- Turn on Photography Tx
- Check Model Selection on Tx – should read Zenmuse
- Check Tx battery voltage (above 7.5v)
- HDMI switch Off
- Freestyle switch Off (FPV On)
    - These settings above are required to initialize the Zenmuse properly. If the switches are in the incorrect position, it will not initialize properly which may cause some of the functions like live video or gimbal operation to not operate properly.
    - If the camera or gimbal do not function properly, disconnect the copter power. Then put all the switches in the proper position for initialization and turn the power back on to the copter.
- Engage power to copter
    - Plug in the 2 battery packs. Typically the battery packs use red T-style connectors in a parallel wire harness. This Y-harness has a yellow connector. It is preferable to connect the batteries to the Y-harness first, then plug in the yellow connector. This reduces (but does not eliminate) electrical arcing.

        - 6 quick chirps should be heard confirming 6S LiPoly batteries are recognized by the ESCs.
            - Hearing less than 6 chirps indicates fewer cell battery packs are being recognized which is incorrect. Check for improper or damaged batteries.
- Do not move or vibrate the Squadcopter until 30 seconds after full GPS Lock
    - Initial 3 red blinks is normal meaning no GPS lock. No red flashes indicates full GPS lock.
    - Continue with checklist as you are waiting for full GPS lock, but do not move the copter.
    - If the GPS takes more than 5 minutes to lock, there is a problem with the area. It is not receiving the proper signals from the satellites. GPS signals are weak, so trees, people, buildings, terrain, weather, have an effect. Move the copter into a more open area where it can more easily see the satellites.
- Check Copter Voltage from both Tx's (transmitters)
    - The transmitters receive a signal from the corresponding receivers. The voltages are regulated to about 5v. If the voltage is below 4.4v or above 6v do not fly. There may be power regulation issues. The receivers cannot work outside this voltage consistently. Also there is some issue if the voltage is outside that range which should be resolved before flying.
- Engage Attitude Mode – Must achieve double amber flash
- Engage GPS Mode – Must achieve double purple flash
- Engage course cock mode – Must achieve double green flash
- Disengage course lock mode. Must achieve double purple flash. Stay in this mode until just prior to takeoff, after takeoff at any time, or do not use.
- Do not engage motors. Set throttle to center position. Must achieve single purple flash when in GPS mode.
    - To verify that the sticks are all centered properly:
    - With throttle in the center position, use the trim buttons on the transmitter to check that the sticks are centered. Trim the roll (the stick located on the right side of the transmitter when moved to the right and left) to the right, counting the number of clicks until a double flash occurs. Then center the trim. Then move the trim to the left, counting the number of clicks until a double flash occurs. An equal number of clicks should be counted each side of center.
    - Do this check for the 3 stick movements other than throttle.
    - Center the trim such that when the stick is in the neutral position that there are equal numbers of clicks in each direction. This ensures that when the sticks are neutralized that the flight controller will recognize this signal and engage GPS mode.

- Calibrate GPS/Compass before the first flight each day or if receiving continuous red blinks or continuous white blinks.
    - Flip the GPS mode switch 7 times very quickly from manual to GPS. End with the switch in the manual position. The indicator light will be blue. Rotate the copter about 1.5 turns in a horizontal position. A green flashing light indicates that this is complete. Then hold the copter vertically and rotate about 1.5 turns. A white flashing light indicates that this is complete. Repeat if necessary until this is completed.
- After calibration, reset the copter by cycling battery with copter pointed in the correct heading for course lock.
- Engage Camera
- HDMI switch On
    - This will stop video from playing on the back of the camera and will send the video signal to the video transmitter via the HDMI connection.
- Freestyle switch On (FPV Off)
    - This allows the camera to be operated freely through the transmitter
- Verify camera operation
    - Operate the shutter
    - Set the focus to auto or manual. Manual setting is usually set to infinity to stop constant focusing of the camera.
- Verify data link if installed
    - Roll the copter about 45 degrees on its side by lifting one side of the copter and resting one side of the landing gear on the ground
    - A corresponding roll should be seen on the gauge.
    - If the copter is rolled to the right, it will appear on the gauge that the horizon rolls to the left – not the right because the view from inside the copter is that the horizon rolls the opposite direction of the copter.
- Verify altitude is about 0 via gauge on computer
    - If it is not about 0, the altitude settings for the waypoints will be off by this amount. This could cause the copter to fly at 10 meters or 30 meters if the waypoint is set for 20 meters and the altitude is off by 10 meters one way or another. If the copter thinks it is at 10 meters when it is on the ground, then it will only rise 10 meters above the ground to achieve what it believes it to be 20 meters above the ground.
    - The altitude can be reset using the ground control software by going to altitude offset. o Alternate Emergency Landing Sites Established

NORMAL TAKEOFF

- Engage GPS mode – Double purple flash when the throttle is down.
- Switch to Course Lock flight mode if required. Purple flashes are replaced with green flashes. Flying in course lock is not required, but helpful in many instances.
- Announce loudly: "CLEAR PROP"
- Move both of the sticks to the bottom left corners to engage the motors. Within 1 second move the throttle up 1/8 – 1/4. The copter should not lift off until about % stick is reached.
- Verify data and video links before lifting off. If anything is not working properly, move the throttle stick to low to disengage the motors and determine a solution.
- If all flight checks are passed, announce loudly: "TAKING OFF"
- Advance throttle to about 3/4. Copter must jump off of the ground to avoid one skid coming up before the other skid, and the skid on the ground getting caught and flipping the copter over sideways.
- Ascend to 3 meters. Then decrease throttle to % to engage the GPS hold.
- Verify links, GPS, Attitude, etc. Should be single purple flash.
- Verify that the copter is holding position within .5m in all directions.
- Verify camera operation
- Verify course lock is operational by rotating 90 degrees and pushing forward on stick.
- Verify copter stability. If unstable, land and reset gains, recalibrate, or retest as necessary.
- Proceed with manual mission or
- For autopilot operation
    - Ascend to 10 meters
    - Command AVO to proceed with mission.
        - Pilot should say "It's yours"
        - Response from AVO "I have it"
- Manual pilot/observer must monitor the informational LED and be ready to take over in manual mode when necessary.
    - White flashes indicates flight controller issue
    - Amber flashes indicates low battery
    - Red flashes indicate loss of GPS or severe battery condition
        - Quick decisions are required when red flashes are indicated
        - 10 seconds or more of loss of GPS signal will stop waypoint guidance and any GPS hold and put into manual mode.

        - Red indicator light battery warning requires immediate landing
    - Manual pilot to request copter flight battery voltage readout from AVO periodically.
        - Reset the first and second indicator lights as required for your set up.
        - When recharging the batteries, the goal is to put 4,000 mah into a 5,000 mah battery pack. Adjust the voltage warnings to your style of flying.
        - Also use the countdown timer on the transmitter. This gives a good indication of battery level because the current used is fairly constant from flight to flight.

POST LANDING

- Note flight time from transmitter. Write this down in the log book.
- Note battery power used during the flight. Write this down in the log book.
- ALWAYS disconnect the main power to the AV first, then turn off the transmitter.
- Check motor temperatures by touching them with your fingers. Any motors which are excessively hot should be further inspected and possibly replaced.
- Check battery temperatures by touching them with your fingers. Battery temperatures should not be hot to the touch. Battery temperatures should be slightly above ambient.
- Inspect all components especially the propellers for wear.
- Note in logbook which batteries were used to calculate life cycle.

AIRCRAFT FLIGHT LOG BOOK

- Keep a log of all flights.
    - Date
    - Time of Day
    - Time in Operation (in hours)
    - Battery serial numbers
    - Mah used in flight
    - Location
    - Pilot, Observer, Sensor Operator Names
    - Flight Objective
    - Remarks

AIRCRAFT MAINTENANCE LOG BOOK

- Keep a log of significant inspections, tests, repairs, alterations, equipment changes.
  - Date maintenance is performed
  - Accumulated hours of operation
  - Remarks

PILOT LOG BOOK

- Keep a log of all flights. Include the following:
  - Aircraft flown
  - Aircraft serial number
  - Date
  - Time of Day
  - Time in Operation (in hours)
  - Location
  - Flight Objective
  - Remarks

SECTION 5
PERFORMANCE

FLIGHT TIMES

- The AV is designed to hover at high efficiency. Hovering is much less efficient than flying on a wing, thus flight times are low compared to fixed wing aircraft.
- All the weight of the AV is supported by power from the batteries. As the batteries are used in a flight, the amount of power available decreases. Therefore the power reserve is constantly decreasing as the battery is being used. Thus loading a rotorcraft above its limit is not recommended. While the AV may have enough power to lift off initially on a full charge, the power reserve at partial charge may be too low to allow for maneuvering and will result in a crash.
- High lateral speeds will add lift to slightly improve efficiency. The rotors act similar to fixed wings at higher speeds. This increase in efficiency may be negated by the increased power consumption of forward flight.
- High winds or gusts decrease efficiency/flight time. The motors work harder to hold position.
- As weight increases flight times decrease.

WIRELESS TRANSMISSION

- Refer to the specific manuals for performance ratings.
- Wireless communications utilized provide acceptable communication for LOS.
- In general:
    - LOS is required
    - The higher the GCS antennas, the better the range
    - Any freq. at may have severe degradation due to location to other admitters such as cell towers
    - RSSI (Received Signal Strength Indication) should be monitored for indication of communication drop out.

SECTION 6
WEIGHT AND BALANCE EQUIPMENT LIST

CG

- CG is critical to the efficient operation of any AV
- When components are shifted, the CG will be altered.
- The main components which are moved on a regular basis are the sensors and the batteries.
- The sensors are typically in the front of the AV, and the batteries are located in the correct position to offset all the components on the AV.
- The CG must be tested after any change to the components or their placement.
- The CG should be tested by lifting the UV with fingers on the bottom of the arms. Check all 3 pairs of arms. The CG should be no more than 2mm off in any on the 3 checks. The closer the CG is to the centerlines of the arms the more efficient and the more stable the AV will be.

WEIGHT

- Weight is critical to the operation of any aircraft
- Weight is especially critical to a rotor wing aircraft. At full throttle the motors have a finite amount of thrust. All the weight is lifted by the battery power, there is no wing to assist in providing lift.
- As the batteries are operated, they lose power. At full charge they have about 25v. At 20% remaining capacity they have about 21v. This is a loss of 8% of the power available which is significant.
- Do not overload the aircraft or there will not be sufficient reserve power to maneuver at low battery levels.

SECTION 7
AIR VEHICLE AND SYSTEMS DESCRIPTION

FUEL/BATTERY REQUIRED

- Manufacturers: Various COTS suppliers.
- Refer to manufacturer data sheet.
- Battery chemistry required: Lithium Polymer
- Battery Capacity: 16,000 mah (minimum)
- Battery cell count required: 6S (6 cells in series)
- Battery Voltage: 21 V minimum at hover, 22.2V nominal, 25.2V maximum
- Battery Minimum Rated Discharge Rate: 20C minimum
- Batteries used simultaneously: 1-4 typical
- Recommended Battery Discharge Amount: 80-90%

WIRELESS COMMUNICATIONS

- Refer to the specific manuals for performance ratings.
- Never power a video transmitter or receiver without an antenna connected or overload failure will occur.
- Wireless communications utilized provide acceptable communication for LOS.
- In general:
- LOS is required.
- Lower frequencies penetrate objects such as trees better than higher freqs.
- Lower freqs have longer range than high freqs
- Higher freqs can transfer more data than lower freqs
- Higher freqs use smaller/shorter antennas
- The higher the GCS antennas, the better the range and reception
- Any freq at may have severe degradation due to location to other admitters such as cell towers
- Range must be constantly monitored.
- Alternate antenna types may be utilized to improve link/range. Patch, helical, omni, etc. can be substituted. They must be verified before use.
- Alternate freqs may be utilized to improve link/range.

SECTION 8
HANDLING, SERVICE AND MAINTENANCE

PROPELLER CARE

- Propellers must be checked each flight for nicks or cracks
- Propellers are designed to last indefinitely if they do not impact dust, dirt or more.

BATTERY CARE AND USE

- Refer to instruction sheet included from the battery manufacturer. Typical information follows.
- Batteries are highly flammable and can explode, especially when fully charged. Improper charging, vibration, impact, high discharge, etc. can lead to explosion and fire. Batteries must be charged under constant supervision and using proper precautions.
- Batteries fully charged must be handled with extreme care.
- Any battery which puffs up is considered damaged and must not be used. It is in a dangerous state. Never charge a puffed up battery.
- Any battery which holds less than 80% of its rated capacity should be discarded.
- Cycle test each battery after every 50 cycles or if a battery is suspected to have lost as significant amount of its capacity to determine the current capacity.
- Properly dispose of batteries. First discharge the battery fully using a battery cycler. Bring to a recycler such as a home improvement store.
- Always charge flight batteries under “balance” mode.
- Flight Battery Recommended Charge Rate: 1 C which takes approximately 1 hour to charge
- Flight Battery Maximum Charge Rate: May exceed 5C. Charge rates higher than 1C will decrease life cycles. Maximum charge rating per the manufacturer will provide 300+ cycles. Use the lowest charge rate which is practical.
- Battery Rest Time between discharging and charging: 30 minutes minimum, 1 hour maximum.
- Do not charge if the battery is more than 2°C warmer than ambient, especially if the temperature is above 20°C. The outer surface is cooler than the inner core after use. Damage will occur when charging a warm battery.
- Recommended Battery Discharge Amount: 80%. Using more of the capacity of the battery will decrease the life cycles
- As battery temperature approaches freezing the capacity of Lithium Polymer batteries decrease. Keep warmer than 5°C before installing into the UV (unmanned vehicle).

- Battery capacity decreases at higher discharge rates. Using more batteries decreases the discharge rate of each battery thereby extending individual battery capacity slightly.
- Lower discharge rates improve the life cycles.
- Batteries are rated at greater than 300 life cycles. 1,000+ life cycles are possible.
- Batteries must not be stored above 60% charged state for extended periods.
- Batteries should be stored below 25°C for extended periods
- Store batteries between 40% - 60% charged state. Fully charge just before use.
- Fully charged batteries which are not to be used within 24 hours should be discharged to 40% - 60% charged state using the battery discharger.
- Using more than one battery at a time requires the proper wiring harness so that the voltage is no more than 25.2V. Over voltage will cause serious damage to electrical equipment.

PREVENTATIVE MAINTENANCE

- ANNUAL INSPECTION
  - If the airframe has in excess of 300 hours in a one year period, an annual inspection must be completed.
  - Disassemble the AV and inspect all components for wear and replace any components as required.
  - Test all batteries for capacity.
  - Upgrade firmware and software to latest revisions
- 500 HOUR PM
  - Disassemble the AV and inspect all components for wear and replace any components as required.
  - Replace all 8 motors.
  - Test all batteries for capacity.
  - Upgrade firmware and software to latest revisions.

SECTION 9
SUPPLEMENTS

COTS components have been utilized in the construction of this AV. All instruction manuals, operating handbooks, warning notices, and more are available as separate documents. Keep these significant documents and keep in a notebook with the copter at all times.

AIRFRAME

AUTOPILOT SYSTEM

BATTERIES

BATTERY CHARGER

CAMERA MANUAL

CAMERA GCS

DATA WIRELESS LINK

GIMBAL CAMERA MOUNT

GIMBAL CAMERA MOUNT SERVOS

LAPTOP COMPUTER

MOTORS

ONBOARD REGULATOR

PROPELLERS

RC/MANUAL COMMAND & CONTROL SYSTEM SPEED CONTROLS (ESCs)

VIDEO CAPTURE HARDWARE

VIDEO CAPTURE SOFTWARE

VIDEO WIRELESS LINK

Attachment 5

DJI S1000

Training Manual

Revision 1 December 16, 2014

I. CONSUMERS ENERGY PIC TRAINING REQUIRMENTS

A. The PIC will have the following qualifications.

1. Private Pilot Certificate

2. Third Class Medical Certificate

3. Completion of DJI Factory-Certified Basic Operator Course

B. Description of DJI Factory-Certified Basic Operator Course

1. Ground Training

<u>16 hour webinar topics</u>

- *General UAV characteristics, types, uses*
- *Principals of Flight*
- *Weight and Balance - Center of Gravity calculations and methods*
- *Operational limitations (vertical speed, horizontal speed, weight, horizontal distance, altitude, endurance, weather, etc.)*
- *Subsystem Operation and Maintenance (Flight controller, IMU, GPS, Compass, Gyros, Accelerometers, Brushless motors, Speed controllers, Propeller, Retractable landing gear, Airframe, Video Transmission and Reception, Antennas, Video displays, etc.)*
- *Battery care*
- *Transponder operation*
- *Maintenance*
- *Record Keeping, Logbooks, and other Documentation*
- *Insurance Requirements*
- *Remote sensing theory and practical application*
- *Autopilot operation and Mission Planning*
- *Aircraft flight simulation*
- *Federal, State, and Local laws, rules, regulations, policies, and good practice*
- *Right of Way rules*
- *FAA Certificate of Authority (COA) process*
- *Pilot in Command (PIC) qualifications and responsibilities*
- *Observer qualifications and responsibilities*
- *Sensor Operator qualifications and responsibilities*
- *Recognizing and setting Early Warning Alarms/Signals*
- *Emergency Procedures*

- *Integration with other aircraft in the national airspace*
- *Reading a sectional map for aircraft*
- *Preflight Checklist*
- *In flight Checklist*
- *Post flight Checklist*
- *Autonomous Flight*
- *Preflight briefing*
- *Checklist reviews*
- *Flight*
- *Certification Testing*
- *How to start a UAV business*
- *Typical income for UAV businesses*
- *Typical charges for photography*

2. Flight Training

a) Flight Training Day 1 – Quadcopters

- *Preflight briefing on quadcopter operation*
- *LOS (Line of Sight) and FPV (First Person View) pilot flight training using quadcopters*

Equipment Used: DJI Phantom

b) Flight Training Day 2 – Fixed Wing Aircraft

- *Preflight briefing on fixed wing operation*
- *LOS (Line of Sight) and FPV (First Person View) pilot flight training using fixed wing aircraft*

Equipment Used: TBM Skyhunter, MyFlyDream Antenna Tracker

c) Flight Training Day 3 – Autopilot Operation

- *Autopilot Mission Training*
- *Create autopilot missions*
- *Pilot flight training via autopilot missions created by the student*

Equipment Used: DJI S1000 fully equipped

Attachment 6

Exemption No. 11062

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
WASHINGTON, DC 20591

In the matter of the petition of **ASTRAEUS AERIAL** for an exemption from part 21; §§ 45.23(b); 61.113(a) and (b); 91.7(a); 91.9(b)(2); 91.103; 91.109; 91.119; 91.121; 91.151(a); 91.203(a) and (b); 91.405(a); 91.407(a)(1); 91.409(a)(2); and 91.417(a) and (b) of Title 14, Code of Federal Regulations	**Regulatory Docket No. FAA-2014-0352**

GRANT OF EXEMPTION

By letter dated May 27, 2014, Jonathan B. Hill, Cooley LLC, Counsel for Astraeus Aerial, and John McGraw, Aerospace Consulting, LLC, Agent for Astraeus Aerial, 1299 Pennsylvania Avenue, NW., Suite 700, Washington, DC 20004 petitioned the Federal Aviation Administration (FAA) on behalf of Astraeus Aerial (Astraeus) for an exemption from part 21, §§ 45.23(b), 61.113(a) and (b), 91.7(a), 91.9(b)(2), 91.103, 91.109, 91.119, 91.121, 91.151(a), 91.203(a) and (b), 91.405(a), 91.407(a)(1), 91.409(a)(2), and 91.417(a) and (b) of Title 14, Code of Federal Regulations (14 CFR). The proposed exemption, if granted, would allow operation of unmanned aircraft systems (UAS) for the purpose of scripted, closed-set filming for the motion picture and television industry.

The petitioner requests relief from the following regulations:

> Part 21 prescribes, in pertinent part, the procedural requirements for issuing and changing design approvals, production approvals, airworthiness certificates, and airworthiness approvals.
>
> Section 45.23(b) prescribes, in pertinent part, that when marks include only the Roman capital letter "N" and the registration number is displayed on limited, restricted or light-sport category aircraft or experimental or provisionally certificated aircraft, the operator

must also display on that aircraft near each entrance to the cabin, cockpit, or pilot station, in letters not less than 2 inches nor more than 6 inches high, the words "limited," "restricted," "light-sport," "experimental," or "provisional," as applicable.

Section 61.113(a) and (b) prescribes that—

(a) no person who holds a private pilot certificate may act as a pilot in command of an aircraft that is carrying passengers or property for compensation or hire; nor may that person, for compensation or hire, act as pilot in command of an aircraft.

(b) a private pilot may, for compensation or hire, act as pilot in command of an aircraft in connection with any business or employment if:

(1) The flight is only incidental to that business or employment; and

(2) The aircraft does not carry passengers or property for compensation or hire.

Section 91.7(a) prescribes, in pertinent part, that no person may operate a civil aircraft unless it is in an airworthy condition.

Section 91.9(b)(2) prohibits operation of U.S.-registered civil aircraft unless there is available in the aircraft a current approved Airplane or Rotorcraft Flight Manual, approved manual material, markings, and placards, or any combination thereof.

Section 91.103 prescribes, in pertinent part, that each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight, to include—

(a) For a flight under IFR or a flight not in the vicinity of an airport, weather reports and forecasts, fuel requirements, alternatives available if the planned flight cannot be completed, and any known traffic delays of which the pilot in command has been advised by ATC;

(b) For any flight, runway lengths at airports of intended use, and the following takeoff and landing distance information:

(1) For civil aircraft for which an approved Airplane or Rotorcraft Flight Manual containing takeoff and landing distance data is required, the takeoff and landing distance data contained therein; and

(2) For civil aircraft other than those specified in paragraph (b)(1) of this section, other reliable information appropriate to the aircraft, relating to aircraft performance under expected values of airport elevation and runway slope, aircraft gross weight, and wind and temperature.

Section 91.109 prescribes, in pertinent part, that no person may operate a civil aircraft (except a manned free balloon) that is being used for flight instruction unless that aircraft has fully functioning dual controls.

Section 91.119 prescribes that, except when necessary for takeoff or landing, no person may operate an aircraft below the following altitudes:

(a) Anywhere. An altitude allowing, if a power unit fails, an emergency landing without undue hazard to persons or property on the surface.

(b) Over congested areas. Over any congested area of a city, town, or settlement, or over any open air assembly of persons, an altitude of 1,000 feet above the highest obstacle within a horizontal radius of 2,000 feet of the aircraft.

(c) Over other than congested areas. An altitude of 500 feet above the surface, except over open water or sparsely populated areas. In those cases, the aircraft may not be operated closer than 500 feet to any person, vessel, vehicle, or structure.

(d) Helicopters, powered parachutes, and weight-shift-control aircraft. If the operation is conducted without hazard to persons or property on the surface—

(1) A helicopter may be operated at less than the minimums prescribed in paragraph (b) or (c) of this section, provided each person operating the helicopter complies with any routes or altitudes specifically prescribed for helicopters by the FAA; and

(2) A powered parachute or weight-shift-control aircraft may be operated at less than the minimums prescribed in paragraph (c) of this section.

Section 91.121 requires, in pertinent part, each person operating an aircraft to maintain cruising altitude by reference to an altimeter that is set “to the elevation of the departure airport or an appropriate altimeter setting available before departure.”

Section 91.151(a) prescribes that no person may begin a flight in an airplane under VFR conditions unless (considering wind and forecast weather conditions) there is enough fuel to fly to the first point of intended landing and, assuming normal cruising speed, (1) during the day, to fly after that for at least 30 minutes; or (2) At night, to fly after that for at least 45 minutes. [emphasis added]

Section 91.203(a) prohibits, in pertinent part, any person from operating a civil aircraft unless it has within it (1) an appropriate and current airworthiness certificate; and (2) an effective U.S. registration certificate issued to its owner or, for operation within the United States, the second copy of the Aircraft Registration Application as provided for in § 47.31(c). Section 91.203(b) prescribes, in pertinent part, that no person may operate a civil aircraft unless the airworthiness certificate or a special flight authorization issued under § 91.715 is displayed at the cabin or cockpit entrance so that it is legible to passengers or crew.

Section 91.405(a) requires, in pertinent part, that an aircraft operator or owner shall have that aircraft inspected as prescribed in subpart E of the same part and shall, between required inspections, except as provided in paragraph (c) of the same section, have discrepancies repaired as prescribed in part 43 of the chapter.

Section 91.407(a)(1) prohibits, in pertinent part, any person from operating an aircraft that has undergone maintenance, preventive maintenance, rebuilding, or alteration unless it has been approved for return to service by a person authorized under § 43.7 of the same chapter.

Section 91.409(a)(2) prescribes, in pertinent part, that no person may operate an aircraft unless, within the preceding 12 calendar months, it has had an inspection for the issuance of an airworthiness certificate in accordance with part 21 of this chapter.

Section 91.417(a) and (b) prescribes, in pertinent part, that—

> (a) Each registered owner or operator shall keep the following records for the periods specified in paragraph (b) of this section:
>
> > (1) Records of the maintenance, preventive maintenance, and alteration and records of the 100-hour, annual, progressive, and other required or approved inspections, as appropriate, for each aircraft (including the airframe) and each engine, propeller, rotor, and appliance of an aircraft. The records must include—
> >
> > (i) A description (or reference to data acceptable to the Administrator) of the work performed; and
> >
> > (ii) The date of completion of the work performed; and

(iii) The signature, and certificate number of the person approving the aircraft for return to service.

(2) Records containing the following information:

(i) The total time in service of the airframe, each engine, each propeller, and each rotor.

(ii) The current status of life-limited parts of each airframe, engine, propeller, rotor, and appliance.

(iii) The time since last overhaul of all items installed on the aircraft which are required to be overhauled on a specified time basis.

(iv) The current inspection status of the aircraft, including the time since the last inspection required by the inspection program under which the aircraft and its appliances are maintained.

(v) The current status of applicable airworthiness directives (AD) and safety directives including, for each, the method of compliance, the AD or safety directive number and revision date. If the AD or safety directive involves recurring action, the time and date when the next action is required.

(vi) Copies of the forms prescribed by § 43.9(d) of this chapter for each major alteration to the airframe and currently installed engines, rotors, propellers, and appliances.

(b) The owner or operator shall retain the following records for the periods prescribed:

(1) The records specified in paragraph (a)(1) of this section shall be retained until the work is repeated or superseded by other work or for 1 year after the work is performed.

(2) The records specified in paragraph (a)(2) of this section shall be retained and transferred with the aircraft at the time the aircraft is sold.

(3) A list of defects furnished to a registered owner or operator under § 43.11 of this chapter shall be retained until the defects are repaired and the aircraft is approved for return to service.

The petitioner supports its request with the following information:

The petitioner has provided the following information – contained in its petition and supplemental proprietary Flight Operations and Procedures Manual (hereafter FOPM) and Motion Picture and Television Operations Manual (hereafter MPTOM) – in support of its exemption request. The petitioner submitted additional information in response to the FAA's August 7, 2014 request which is posted to the docket. The FAA has organized the petitioner's information into three sections: 1) the unmanned aircraft system, 2) the UAS Pilot In Command (PIC), and 3) the UAS operating parameters.

Unmanned Aircraft System

The UAS proposed by the petitioner is a proprietary design, conceived and constructed by Astraeus Aerial, and referred to as the Astraeus Aerial Cinema System V.3CS UAS aircraft variant, serial #001 onward (hereafter referred to as V.3). This aircraft has eight rotors and eight motors in a quadcopter configuration (X8). The petitioner states that given the size, weight, speed, and limited operating area associated with the aircraft to be utilized by the applicant, an exemption from 14 CFR part 21, Subpart H (Airworthiness Certificates), subject to certain conditions and limitations, is warranted and meets the requirements for an equivalent level of safety under 14 CFR part 11 and Section 333 of the FAA Modernization and Reform Act of 2012 (PL 112-95). The petitioner further states that UAS operated without an airworthiness certificate in the restricted environment and under the conditions and limitations proposed by the petitioner will be at least as safe, or safer, than a conventional aircraft (fixed wing or rotorcraft) operating with an airworthiness certificate issued under 14 CFR part 21, Subpart H and not subject to the proposed conditions and limitations.

The petitioner states that the unmanned aircraft (UA) to be operated under this request is less than 55 lbs. fully loaded, flies at a speed of no more than 50 knots, carries neither a pilot nor passenger, carries no explosive materials or flammable liquid fuels, and operates exclusively within a secured area as set out in the MPTOM. In addition, the petitioner has integrated safety features into the design of the UAS, as described in the petitioner's FOPM, to ensure the safety of persons and property within and surrounding the limited operating area. The petitioner further describes that, in the event the UAS loses communications or its GPS signal, the UA will have the capability to return to a pre-determined location within the Security Perimeter and land. It will also have the capability to abort a flight in the event of unpredicted obstacles or emergencies.

The petitioner states that even though its UAS will have no airworthiness certificate, an exemption may be needed from 14 CFR § 45.23 as the UA will have no entrance to the cabin, cockpit, or pilot station on which the word "experimental" can be placed. Given the size of the UA, the petitioner notes that the two-inch lettering will be impossible. The petitioner asserts that an equivalent level of safety will be provided by having the UA marked with the word "experimental" on the fuselage in compliance with 14 CFR § 45.29(f), in a location where the pilot, observer, and others working with the UA will see the identification.

The petitioner states that the maintenance requirements in the pertinent sections of 14 CFR part 91 are only applicable to aircraft with an airworthiness certificate in accordance with part 43. The petitioner states that its V.3 UAS does not have specific maintenance instructions; therefore the petitioner has developed and documented in its MPTOM and FOPM an "on-condition" maintenance process for the V.3 UAS affected by this exemption. The petitioner has also stated that it intends to follow any manufacturers' recommended instructions and procedures when those procedures exist for certain components of its V.3 UAS.

UAS Pilot In Command (PIC)

The petitioner asserts that since the UA will not carry a pilot or passengers on board, the proposed operations will not adversely affect safety by requiring the PIC operating the aircraft to have a private pilot's license rather than a commercial pilot's license. In support of its position, the petitioner argues that, since there are no standards for either private or commercial UAS pilot certificates, knowledge of airspace regulations and dexterity in the control and operation of the UAS acquired from actual operation of the aircraft will be the most important factors in establishing an equivalent level of safety. Furthermore, the petitioner explains that, given the restricted and controlled airspace within which operations will take place, the key factors needed by the PIC are knowledge of the airspace within which the "closed-set filming" operation will take place and how that airspace fits into the National Airspace System (NAS). The petitioner also states that it cannot be assumed that a commercial pilot, approved to operate a helicopter or fixed wing aircraft, has the skill or ability to safely operate an unmanned aerial vehicle, operating at 400 feet AGL or lower, within strictly controlled pre-approved airspace. The petitioner asserts that there are relatively few certificated pilots who are also qualified to fly the type of UAS utilized in motion picture industry image-capture operations. Astraeus further asserts that there are even fewer commercially certificated pilots that can fly these UAS, to the point that to do both is considered rare.

Additionally, the petitioner states that the aircraft will be operated within a secure environment, which no one will be allowed to enter unless they are part of the production, have been fully briefed of the risks prior to operation of the UAS, and have consented to the risks associated with being in the operating area. Should there be a mishap, the UA being flown pose significantly less of a threat than the helicopters and fixed wing aircraft now being employed because they are a fraction of the size, carry no flammable fuel, and do not carry crew or passengers. This is in stark contrast to conventional aircraft that are flown to the site, carry flammable fuel, carry passengers and crew, and operate in a much larger area.

UAS Operating Parameters

The petitioner states that all flights will be operated within visual line of sight (VLOS) of a pilot and/or observer, and that the UA flights will be limited to a maximum altitude of 400 feet AGL. The petitioner further states that an operator will ensure that only consenting production personnel will be allowed within 100 feet of the UA operation, but this radius may be reduced to 30 feet based upon an equivalent level of safety determination, as stated in their MPTOM, with the advance permission of the local Flight Standards District Office (FSDO). The petitioner asserts that an equivalent level of safety can be achieved given the size, weight,

and speed of the UAS, as well as the location where it is operated. The petitioner states that the UAS will be operated within a safe operating perimeter, the boundaries of which will be determined by production personnel and the UAS PIC based on the site-specific filming activities and speed of the UAS required for the operation, and coordinated with the jurisdictional FAA FSDO and local government officials as applicable, as outlined in the MPTOM and FOPM. The petitioner states that only participating and consenting production personnel will be allowed within this perimeter; the petitioner also states their intention to comply with the guidelines outlined in Order 8900.1 V3, C8, S1 with regard to nonparticipating personnel outside the safety perimeter. The petitioner argues that, compared to flight operations with aircraft or rotorcraft weighing far more than its maximum 55 lb. UA, and the lack of flammable fuel, any risk associated with its UAS operations is far less than those with conventional aircraft operating at or below 500 feet AGL in the movie industry.

With respect to preflight actions, the petitioner notes it may need an exemption from 14 CFR § 91.103, because it will not have approved rotorcraft flight manuals. The petitioner asserts that an equivalent level of safety will be achieved by the PIC taking all preflight actions as set forth in their MPTOM and FOPM, including reviewing weather, flight battery requirements, landing and takeoff distances, and aircraft performance data before initiation of flight. Additionally, the petitioner states that a briefing will be conducted prior to each day's filming regarding planned UAS operations, and all personnel who will be performing duties within the boundaries of the safety perimeter will be required to attend.

With respect to the fuel requirements, the petitioner notes that, in order to meet the 30 minute reserve requirements in 14 CFR § 91.151, UAS flights would have to be limited to approximately 10 minutes. The petitioner argues that, given the limitations on the UA's proposed flight area and the location of its proposed operations within a predetermined area, a longer time frame for flight in daylight or night VFR conditions is reasonable. The petitioner believes that an equivalent level of safety can be achieved by limiting flights to 30 minutes or 25% of battery power, whichever occurs first.

The petitioner notes that it may need an exemption from 14 CFR § 91.121, as its UAS may have a GPS altitude read out instead of a barometric altimeter. The petitioner asserts that an equivalent level of safety will be achieved, as outlined in its MPTOM. Specifically, the altitude information will be provided to the UAS PIC via a digitally encoded telemetric data feed. Prior to each flight, a zero altitude initiation point will be established and confirmed for accuracy by the PIC.

Public Interest

The petitioner states that, given the small size of the UA involved and the restricted sterile environment within which it will operate, its proposed operation "falls squarely within that zone of safety (an equivalent level of safety) in which Congress envisioned that the FAA must, by exemption, allow commercial operations of UAS to commence immediately." Also due to the size of the UA and the restricted areas in which the UAS will operate, approval of the application presents no national security issue. The petitioner states that, given the clear direction in Section 333, the strong equivalent level of safety surrounding the proposed operations, and the significant public benefit, including enhanced safety, reduction in

environmental impacts, and including reduced emissions associated with allowing UAS for movie and television operations, granting the requested exemptions is in the public interest.

Discussion of Public Comments:

A summary of the petition was published in the Federal Register on June 26, 2014 (79 FR 36378). Eighty-six comments were received.

Of the 86 comments received, including eight from associations, 50 comments supported the exemption request, 22 opposed, and 14 were neutral. The petition received comments on the following topics: economic impact, UAS, PIC, operational capabilities, airspace, privacy, sense and avoid, and data link.

Comments supporting the exemption request came from individuals and industry groups, including the Association of Unmanned Vehicle Systems International (AUVSI), Aerospace Industries Association (AIA), the National Association of Realtors, the News Media Coalition, and the National Press Photographers Association. Supporting comments cited the petitioner's intent to use controlled access airspace, licensed airmen, and preflight safety briefings, as well as the economic benefits of UAS.

Several trade organizations submitted letters to the docket, expressing various issues and concerns with the Astraeus petition for exemption, including the Air Line Pilots Association International (ALPA), the National Agricultural Aviation Association (NAAA), and the United States Hang Gliding and Paragliding Association (USHPA).

ALPA expressed concern regarding certain conditions outlined in Astraeus' petition. ALPA notes that the proposed operations will be for "compensation or hire," and ALPA believes that the pilot must hold at least a current FAA Commercial Pilot Certificate with an appropriate category and class rating for the type of aircraft being flown as well as specific and adequate training on the UAS make and model intended to be used. Similarly, a current 2nd Class FAA Medical certificate should be required for a UAS pilot operating an aircraft for compensation or hire commercial operations as is required in the NAS today. NAAA and USHPA also commented on pilot qualification. Specifically,

> NAAA believes that the Part 61 regulations currently in effect do not address the licensing of pilots of an unmanned aircraft used for commercial purposes. We believe it is necessary for the FAA to evaluate pilots of these aircraft on their knowledge and skills in UAV operations. Requirements for this licensing should be developed along with other rigorous rules and qualifications to ensure safe integration of the unmanned aircraft into the NAS.

The FAA has carefully reviewed the knowledge and training required by holders of both private and commercial certificates, as well as the separation of Astraeus' proposed operations from other manned operations. Additional details are available in the ensuing analysis of this issue with regards to 14 CFR § 61.113.

ALPA commented that although the anticipated operation is expected to occur below 400 feet above the surface, the petition also makes reference to operations 200 feet above structures of unspecified and therefore unlimited height. This would put the aircraft at the same altitude

strata as other aircraft in the NAS, with only geographic separation to mitigate the risk of collision. However, in subsequent materials posted to the docket, Astraeus has removed operation from elevated platforms. All operations will be limited to 400 feet AGL, which is specified in the conditions and limitations below.

ALPA further notes that the aircraft "may not have a barometric altimeter" so the ability to accurately maintain altitude must be addressed. NAAA noted the same in its comments. The FAA agrees with ALPA and NAAA and addresses this concern in its analysis of the exemption from 14 CFR § 91.121, finding that the alternative means of compliance proposed by Astraeus does not adversely affect safety.

ALPA and an individual comment that Command and Control (C2) link failures are one of the most common failures on a UAS, and that lost link mitigations should require safe modes to prevent fly-aways or other scenarios. The FAA agrees and carefully examined the proposed operation to ensure that the vehicle design and the petitioner's MPTOM and FOPM addressed potential hazards related to C2 failure. The FAA finds that the UAS to be operated by Astraeus has sufficient design features to address these hazards. The FAA also finds that the MPTOM and FOPM have incorporated safety procedures to be followed by all operational participants should a C2 failure occur. Further detail is contained in the analysis of the UAS below.

NAAA stated that it represents the interests of small business owners and pilots licensed as commercial applicators. NAAA members operate in low-level airspace, and clear low-level airspace is vital to the safety of these operators.

NAAA stated that seeing and avoiding other aircraft and hazardous obstructions is the backbone for agricultural safety, and agricultural pilots depend on pilots of other aircraft to perform their see and avoid functions needed to prevent collisions. NAAA believes that UA operations at low altitudes will increase the potential of collision hazards with agricultural aircraft. In its comments, the USHPA submitted similar concerns relative to activities of other low altitude user groups including ballooning, skydiving, powered ultralights, etc.

NAAA acknowledged Astraeus' plan to submit a written Plan of Activities to the FSDO three days before the proposed operations, as required by the petitioner's MPTOM. However, NAAA maintains, as does the USHPA, that in addition to this, issuance of a NOTAM advising nonparticipating pilots of the planned activity is vital to disseminating this safety information. The FAA agrees and has incorporated this into the conditions and limitations of this exemption. Further detail is contained in the analysis of the operating parameters below.

NAAA commented that UA should have assigned numbers that can be read from a suitable distance to aid in identification when enforcement of flight regulations is required. The USHPA commented similarly, noting that while the current identification standards are not feasible on small UA given their reduced size, identification appropriate for these design parameters could be defined and created without undue burden or negative impacts on UAS operations. The FAA partially agrees with NAAA and USHPA. UA operated under this exemption will be marked in accordance with 14 CFR part 45 or as otherwise authorized by the FAA. Further detail is contained in the analysis of the UAS below.

USHPA states that it is a nonprofit member organization with the specific and primary purpose to engage exclusively for scientific and educational purposes in the development, study, and use of fuel-less flight systems and aircraft capable of being launched by human power alone. USHPA commented that it believes with proper notification of time and place, along with other considerations, safety can be maintained. USHPA's notification concerns will be addressed by the conditions and limitations that will require an Air Traffic Organization issued Certificate of Waiver or Authorization (COA) to address airspace requirements and notification. Further detail is contained in the analysis of the UAS operating parameters below.

Related to the operation of the UA within visual line of sight (VLOS) of the pilot and/or observer, USHPA believes operation of any UA in three-dimensional space presents unique challenges in accurately determining position in relation to stationary or mobile objects. USHPA comments that utilization of an observer for operational redundancy is prudent and encouraged, but should not be considered a viable replacement for the pilot in command. USHPA believes that the identification of navigational requirements and accurately conveying them to the pilot in command would not be provided with adequate precision or sufficient response time in a crisis situation and recommends that dual control systems be utilized as a redundant safety measure common in commercial aviation environments. The FAA notes USHPA's concerns; additional detail is provided in the analysis of the UAS below.

USHPA also asserts that manned flight should always maintain right of way over all UA operations. The FAA agrees and has incorporated this into the conditions and limitations of this exemption.

Several comments noted that small UAS can be hard to see during the day, due to their small size and factors such as sun glare. Commenters also noted concerns with regard to weather and wind conditions affecting operations. The FAA addressed these concerns by adding operating restrictions in the conditions and limitations regarding stand-off distance from clouds, altitude restrictions, and operating distance from non-participating personnel. Further detail is contained in the analysis of the UAS operating parameters below.

The petition received several comments suggesting that UAS operated under this exemption should have the ability to monitor and communicate with other aircraft or install transponders, or that the UAS should not operate until they can sense and avoid other aircraft. One commenter suggested that the FAA should implement a buffer between these UAS operations and manned operations, while another raised concern with near misses with other aircraft. Two comments noted that UAS are susceptible to accidents and GPS jamming. The FAA believes the limitations under which the petitioner will operate (i.e. VLOS and at or below 400 feet AGL) and the UAS emergency procedures as outlined in the petitioner's FOPM and MPTOM are sufficient mitigations to this risk so that the operations will not adversely affect safety. Further information is contained in the analysis of the UAS below.

One commenter suggested that the FAA should require testing of software and systems prior to operation, including testing to RTCA standards. The FAA believes the preflight checks discussed in the analysis of the UAS operating parameters are sufficient to mitigate this risk, and addresses this in the conditions and limitations below.

The FAA also received comments not related to the UA and its operation as proposed by the petitioner, but rather addressing more general UAS issues, which are discussed below.

The FAA received two comments asking how the FAA plans to monitor or conduct surveillance of the petitioner's UAS operations. The FAA expects operators to comply with its regulations and the terms of the exemption. The jurisdictional FSDO will be the primary office responsible for oversight of the operations.

The FAA received several comments that integrating UAS operations via a broadly applicable rule was a more suitable method than the exemption process, and that industries other than the motion picture industry should be allowed to participate. Section 333 provides interim authority to the Secretary of Transportation, which facilitates limited, controlled UAS operations prior to the completion of a UAS regulatory structure. The FAA is using its exemption process to facilitate implementation of Section 333 and to address FAA rules that would be applicable to the proposed operations. We have received and are considering exemption petitions from a broad array of industries and applications for this technology. Additionally, the FAA is engaged in a rulemaking process that will allow broader applications of UAS operations.

Two commenters suggested this exemption process should be available to anybody, regardless of organizational size or resources. The FAA will consider any request for exemption submitted to it, no matter the source.

One commenter stated that meaningful public review of the petition was not possible because some of the documents submitted by the petitioner are confidential. The FAA routinely considers confidential materials in its exemption process. The FAA reviewed and considered the petitioner's information in its analysis of the petition.

The petition received several comments on privacy. A commenter expressed concern that the UAS could be used for spying. Other commenters stated that there are strong privacy regulations in place. Specifically, a commenter states that the petitioner addressed privacy issues in its request by mandating that all filming be within a contained environment with all participants fully aware that they are being filmed. The petitioner states that all UAS flights will occur over private or controlled access property with the property owner's prior consent and knowledge, and that only people who have consented or otherwise have agreed to be in the area where filming will take place will be filmed. The FAA notes that the terms of this grant of exemption are consistent with the petitioner's proposal in this area.

The FAA's analysis is as follows:

Unmanned aircraft system (UAS)

Regarding the petitioner's requested relief from 14 CFR part 21 Certification procedures for products and parts, the FAA finds that, based on the limited size, weight, operating conditions, design safety features, and the imposed conditions and limitations, the petitioner has demonstrated that its operations would not adversely affect safety compared to similar

operations conducted with aircraft that have been issued an airworthiness certificate under 14 CFR part 21, Subpart H.

Commercial motion picture and television aerial filming operations with manned aircraft are typically conducted with aircraft holding standard airworthiness certificates issued under part 21, subpart H. These aircraft are normally modified via the Supplemental Type Certificate (STC) process to install cameras and other equipment not included in the original aircraft design.

Manned helicopters conducting motion picture and television aerial filming can weigh 6,000 lbs. or more and are operated by an onboard pilot, in addition to other onboard crewmembers, as necessary. The petitioner's UA will weigh less than 55 lbs. with no onboard pilot or crew. The pilot and crew will be remotely located from the aircraft. The limited weight significantly reduces the potential for harm to participating and nonparticipating individuals or property in the event of an incident or accident. The risk to an onboard pilot and crew during an incident or accident is eliminated with the use of a UA for the aerial filming operation.

Manned aircraft are at risk of fuel spillage and fire in the event of an incident or accident. The UA carries no fuel, and therefore the risk of fire following an incident or accident due to fuel spillage is eliminated.

During motion picture and television aerial filming with manned aircraft under the conditions of an FAA issued Certificate of Waiver, aircraft can be operated in very close proximity to participating persons. The safety of these individuals is maintained through use of an aircraft with standard airworthiness certification under 14 CFR part 21, Subpart H, operation of the aircraft by a qualified and competent pilot, and operating according to limitations necessary to ensure safety. In these situations, the filming subject and production personnel are exposed to risk by virtue of their close proximity to an aircraft in flight. Compared to manned aircraft, the UA being operated by the petitioner reduces the risk to participating persons in close proximity to the aircraft due to the limited size, weight, operating conditions, and design safety features of the UAS.

This exemption does not require an electronic means to monitor and communicate with other aircraft, such as transponders or sense and avoid technology. Rather the FAA is mitigating the risk of these operations by placing limits on altitude, requiring stand-off distance from clouds, permitting daytime operations only, and requiring that the UA be operated within visual line of sight and yield right of way to all other manned operations. Additionally, the exemption provides that the operator will request a NOTAM prior to operations to alert other users of the NAS.

The petitioner's UAS has the capability to operate safely after experiencing certain in-flight failures. The UA is also able to respond to a lost-link event with a pre-coordinated, predictable, automated flight maneuver. With regard to USHPA's concerns about dual control systems, current FAA regulations permit motion picture and television filming operations by manned aircraft that do not require a copilot. Additionally, under this exemption, the FAA requires that the UAS PIC hold a current third class medical certificate. Historically, instances of complete PIC incapacitation are rare. In all other cases other than complete incapacitation,

the PIC has the ability to terminate the flight operation or initiate the automated return to home procedure outlined within the FOPM. The FAA also believes that the multiple control redundancies described in the petitioner's FOPM are sufficient to mitigate risks associated with the loss of GPS signal. In consideration of these factors and the UA size, weight, speed and other operating limitations associated with this aerial filmmaking operation, the FAA finds that there is no adverse safety affect relative to similar operations conducted by manned aircraft with a flight crew complement of one.

These safety features also provide for no adverse safety affect to participating and nonparticipating individuals compared to a manned aircraft that holds a standard airworthiness certificate performing a similar operation.

In accordance with the statutory criteria provided in Section 333 of PL 112-95 in reference to 49 USC 44704, and in consideration of the size, weight, speed, and limited operating area associated with the aircraft and its operation, the Secretary of Transportation has determined that this aircraft meets the conditions of Section 333. Therefore, the FAA finds that the requested relief from 14 CFR part 21, and any associated noise certification and testing requirements of part 36, is not necessary.

Regarding the petitioner's requested relief from 14 CFR § 45.23(b) Display of marks, the petitioner's request is made under the assumption that marking with the word "experimental" will be required as a condition of an exemption request. This marking is reserved for aircraft that are issued experimental certificates under § 21.191. Since the petitioner's UAS will not be certificated under 14 CFR § 21.191, a grant of exemption for 14 CFR § 45.23(b) is not necessary.

The petitioner's UA must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification (N-Number) markings in accordance with 14 CFR part 45, Subpart C. Markings must be as large as practicable.

Regarding the petitioner's requested relief from 14 CFR §§ 91.405(a) Maintenance required, 91.407(a)(1) Operation after maintenance, preventive maintenance, rebuilding, or alteration, 91.409(a)(2) Inspections, and 91.417(a) and (b) Maintenance records, the FAA has determined that relief from 91.409(a)(1) is also necessary, because it is an alternate inspection requirement of 91.409(a)(2).

The petitioner's FOPM contains the maintenance requirements for the V.3 UAS, to include "on-condition" maintenance and modifications. The petitioner's MPTOM and FOPM were reviewed and do not sufficiently support the regulatory relief sought under 14 CFR part 91, Subpart E. The FAA has carefully considered the petitioner's supplemental information and determined that its operations will not adversely affect safety with regard to the regulatory maintenance and alteration requirements of 14 CFR §§ 91.405(a)(1), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b), provided changes are made to the MPTOM and FOPM as required by the conditions and limitations included in this exemption. These changes include: requirements to develop and document maintenance, overhaul, replacement, and inspection requirements in the absence of manufacturer's requirements; procedures to document and maintain maintenance records with regard to the petitioner's UAS; and UAS

technician qualification criteria. They also require the petitioner's FOPM to include preflight inspection procedures that account for any discrepancies not already covered in the manual. The FAA finds these additional requirements are necessary to ensure the petitioner's proposed UAS operations do not adversely affect safety in the NAS and of people and property on the ground. Therefore, the FAA finds that exemption from 14 CFR §§ 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a) and (b) is warranted subject to the conditions and limitations below.

Pilot In Command of the UAS

Regarding the petitioner's requested relief from 14 CFR § 61.113(a) and (b) Private pilot privileges and limitations, comments were received that voiced concerns about pilot certification. One such comment came from ALPA, which states that one of the "areas that must be addressed to ensure safe operations" is Astraeus' proposal to use a private pilot with a third class medical as its UAS PIC. ALPA believes that the UAS pilot should possess a commercial pilot certificate with appropriate category and class rating for the type of aircraft being flown and the corresponding second class medical certificate, as well as specific and adequate training on the UAS make and model intended to be used. Similar concerns were also raised by other associations such as USHPA and NAAA.

Given these grounds, the FAA must determine the appropriate level of pilot certification for Astraeus' proposed operation. Title 14 CFR part 61 requires that operations conducted for compensation or hire necessitate a commercial pilot certificate and at least a second class medical certificate. In considering the petitioner's requested relief from 14 CFR § 61.113(a) and (b), the FAA must consider the following factors as they relate specifically to Astraeus' proposed operations:

Separation from manned aircraft operations: Astraeus proposes operations in a "sterile environment" of closed-set motion-picture filming. In this controlled environment, their operations will remain within visual line of site (VLOS) and below 400 feet AGL. Additionally, the FAA has added further conditions and limitations that will require a Certificate of Waiver or Authorization (COA) from the FAA Air Traffic Organization to address airspace requirements and notification requiring Astraeus to request a Notice to Airman (NOTAM) not more than 72 hours in advance, but not less than 48 hours prior to the operation. Astraeus will also be required to avoid and yield right-of-way to all manned operations.

The current aeronautical knowledge requirements for a private pilot compared to a commercial pilot: The FAA analyzed the areas of knowledge specified in 14 CFR part 61 for that of a commercial pilot versus a private pilot. The results show that the required areas of knowledge for a commercial versus private pilot cover the same fundamental principles, as shown in the following table.

Commercial Knowledge	Private Knowledge
****Airplane Single Engine Land (ASEL) used for comparison****	
§ 61.125 Aeronautical knowledge. *(a) General.* A person who applies for a commercial pilot certificate must receive and log ground training…	**§ 61.105 Aeronautical knowledge.** *(a) General.* A person who is applying for a private pilot certificate must receive and log ground training…
(b) **Aeronautical knowledge areas.**	(b) **Aeronautical knowledge areas.**
(1) Applicable Federal Aviation Regulations of this chapter that relate to commercial pilot privileges, limitations, and flight operations;	(1) Applicable Federal Aviation Regulations of this chapter that relate to private pilot privileges, limitations, and flight operations;
(2) Accident reporting requirements of the National Transportation Safety Board;	(2) Accident reporting requirements of the National Transportation Safety Board;
(3) Basic aerodynamics and the principles of flight;	(10) Principles of aerodynamics, powerplants, and aircraft systems;
(4) Meteorology to include recognition of critical weather situations, windshear recognition and avoidance, and the use of aeronautical weather reports and forecasts;	(6) Recognition of critical weather situations from the ground and in flight, windshear avoidance, and the procurement and use of aeronautical weather reports and forecasts;
(5) Safe and efficient operation of aircraft;	(7) Safe and efficient operation of aircraft, including collision avoidance, and recognition and avoidance of wake turbulence;
(6) Weight and balance computations;	(9) Weight and balance computations;
(7) Use of performance charts;	(8) Effects of density altitude on takeoff and climb performance;
(8) Significance and effects of exceeding aircraft performance limitations;	**Related to other areas within the private requirements but not referenced specifically**
(9) Use of aeronautical charts and a magnetic compass for pilotage and dead reckoning;	(4) Use of aeronautical charts for VFR navigation using pilotage, dead reckoning, and navigation systems;
(10) Use of air navigation facilities;	(4) Use of aeronautical charts for VFR navigation using pilotage, dead reckoning**, <u>and navigation systems</u>**; (5) Radio communication procedures;
(11) Aeronautical decision making and judgment;	(12) Aeronautical decision making and judgment; and
(12) Principles and functions of aircraft systems;	(10) Principles of aerodynamics, powerplants, and aircraft systems;
(13) Maneuvers, procedures, and emergency operations appropriate to the aircraft;	(7) Safe and efficient operation of aircraft, including collision avoidance, and recognition and avoidance of wake turbulence; (11) Stall awareness, spin entry, spins, and spin recovery techniques for the airplane and glider category ratings;
(14) Night and high-altitude operations; **	**Although not mentioned in § 61.105, 3 hours of night flight training is required for the private per § 61.107 and § 61.109. For this comparison, high-altitude operations are considered not applicable.**
(15) Procedures for operating within the National Airspace System; and	(3) Use of the applicable portions of the "Aeronautical Information Manual" and FAA advisory circulars; (13) Preflight action that includes— (i) How to obtain information on runway lengths at airports of intended

	use, data on takeoff and landing distances, weather reports and forecasts, and fuel requirements; and (ii) How to plan for alternatives if the planned flight cannot be completed or delays are encountered.
(16) Procedures for flight and ground training for lighter-than-air ratings.**	**For this comparison (ASEL), these operations are considered not applicable.**
§ 61.127 Flight proficiency. (a) *General.* A person who applies for a commercial pilot certificate must receive and log **ground** and flight training	**§ 61.107 Flight proficiency.** (a) *General.* A person who applies for a private pilot certificate must receive and log **ground** and flight training
(b) *Areas of operation.* (1) For an airplane category rating with a single-engine class rating:	(b) *Areas of operation.* (1) For an airplane category rating with a single-engine class rating:
(i) Preflight preparation;	(i) Preflight preparation;
(ii) Preflight procedures;	(ii) Preflight procedures;
(iii) Airport and seaplane base operations;	(iii) Airport and seaplane base operations;
(iv) Takeoffs, landings, and go-arounds;	(iv) Takeoffs, landings, and go-arounds;
(v) Performance maneuvers;	(v) Performance maneuvers;
(vi) Ground reference maneuvers;	(vi) Ground reference maneuvers;
(vii) Navigation;	(vii) Navigation;
(viii) Slow flight and stalls;	(viii) Slow flight and stalls;
(ix) Emergency operations;	(x) Emergency operations;
(x) High-altitude operations; and	**For this comparison, high-altitude operations are considered not applicable.**
(xi) Postflight procedures.	(xii) Postflight procedures.
Not referenced specifically	(ix) Basic instrument maneuvers;
Not referenced specifically	(xi) Night operations, except as provided in §61.110 of this part; and

The specific UAS airmanship skills required for Astraeus' PIC(s): Some of the requirements for Astraeus' PIC(s) are provided in their proprietary documents. However, as with other exemptions that contain specific pilot qualifications, e.g. Exemption Nos. 7830, 6802K, and 6540N, those pilot requirements become conditions and limitations within the grant of exemption. An abbreviated summary of those PIC requirements include the following:

a. The PIC must possess a Private Pilot's Certificate and a valid third-class medical certificate;

b. The PIC must have accumulated and logged a minimum of 200 flight cycles and 25 hours of total time as a UAS rotorcraft pilot and at least 10 hours logged as a UAS pilot with a similar UAS type (single blade or multirotor).

c. The PIC must have accumulated and logged a minimum of five hours as UAS pilot with the make and model of UAS to be utilized for operations under the exemption and three take-offs and landings in the preceding 90 days.

d. The PIC must have successfully completed the qualification process as specified in the MPTOM and FOPM, to include a knowledge and skill test.

The FAA's analysis regarding PIC requirements: The parallel foundation of aeronautical knowledge required for private and commercial pilots is shown in the above table. Private

pilot airmanship skills are furthered through manned flights in the NAS. Commercially certificated pilots build additional experience through these manned flights as well. The additional experience and airmanship skills obtained by commercially certificated airmen contribute to their ability to overcome adverse situations that could be encountered in flights conducted for compensation or hire. However, the experience obtained beyond a private pilot certificate in pursuit of a commercial pilot certificate in manned flight does not necessarily aid a pilot in the operational environment proposed by the petitioner; the FAA considers the overriding safety factor for the limited operations proposed by the petitioner to be the airmanship skills acquired through UAS-specific flight cycles, flight time, and specific make and model experience, culminating in verification through testing.

The FAA shares ALPA's concerns regarding appropriate training on the UAS being utilized. The FAA has reviewed the petitioner's knowledge and experience criteria for its PICs. The FAA finds that the combination of aeronautical knowledge, UAS airmanship skills, and verification through testing is a sufficient method for Astraeus to evaluate a pilot's qualifications, given that operations will be conducted within the limitations outlined in this exemption.

The knowledge and airmanship test qualifications have been developed by Astraeus for the UAS operations proposed in their petition for exemption. There are no established practical test standards that support a jurisdictional FAA FSDO evaluation and approval of company designated examiners. The petitioner will conduct these tests in accordance with its FOPM and the conditions and limitations noted below. Given the constraints of the proposed operations, the FAA believes this would not adversely affect the safety of the NAS.

The petitioner plans to operate in a unique and limited environment. Given the 1) separation of these closed-set filming operations from other manned operations, 2) the parallel nature of private pilot aeronautical knowledge requirements to those of commercial requirements, and 3) the UAS airmanship skills of Astraeus' PICs, the FAA finds that the additional manned airmanship experience of a commercially certificated pilot would not correlate to the airmanship skills necessary for Astraeus' specific proposed operations. Upon consideration of the overall safety case presented by the petitioner and the concerns of the commenters, the FAA finds that granting the requested relief from 14 CFR § 61.113(a) and (b), provided the conditions and limitations outlined below, would not adversely affect the safety of the NAS.

Another consideration supporting the certificate requirement is that pilots holding a private pilot certificate are subject to security screening by the Department of Homeland Security. This requirement should ameliorate security concerns over UAS operations under this exemption.

Operating parameters of the UAS

Astraeus has stated that it plans to comply with the waiver process as described in FAA Order 8900.1, Volume 3, Chapter 8, Section 1 (V3, C8, S1) Issue a Certificate of Waiver for Motion Picture and Television Filming. The FAA agrees with this philosophy; however, the current section of Order 8900.1 has specific processes that preclude a jurisdictional FAA FSDO from issuing the required Certificate of Waiver, because the section did not originally provide for

UA operations. One example of this is the minimum pilot qualifications – the pertinent section of Order 8900.1 provides no way to relieve Astraeus from the pilot requirements. Also, the sample form 7711-1 used for issuing the Certificate of Waiver specifically states "this section not used for Unmanned Air Vehicle authorizations."

Therefore, the FAA will exempt Astraeus from the applicable regulations normally waived during that process. The FAA will then include the required notifications and coordination with jurisdictional FSDOs through the conditions and limitations listed below. Motion picture and television filming waivers similar to Astraeus' operation are normally issued from one jurisdictional FSDO and can be used in locations covered by other geographically responsible FSDOs through notification. Those local FSDOs then have the ability to review the proposed plan of activities and associated operations manual(s) and levy any additional local special provisions. Since Astraeus' operation deals specifically with UAS, this exemption will take the place of the Certificate of Waiver normally issued by a jurisdictional FSDO under 8900.1 V3, C8, S1. Every FSDO with jurisdiction over the area that Astraeus plans to operate within must still be notified, just as with manned filming operations, and those FSDOs will have the ability to coordinate further conditions and limitations with the UAS Integration Office to address any local concerns, as stated below in the conditions and limitations section of this exemption.

The petitioner must also obtain a Certificate of Waiver or Authorization (COA) from the FAA's Air Traffic Organization (ATO) prior to conducting any operations. This is an existing process that not only makes local Air Traffic Control (ATC) facilities aware of UAS operations, but also provides ATO the ability to consider airspace issues that are unique to UAS operations. The COA will require the operator to request a Notice to Airman (NOTAM), which is the mechanism for alerting other users of the NAS to the UAS activities being conducted. Therefore, the FAA believes that adherence to this process is the safest and most expeditious way to permit Astraeus to conduct their proposed UAS operations. The conditions and limitations below prescribe the requirement for Astraeus to obtain an ATO-issued COA.

Regarding the petitioner's requested relief from 14 CFR § 91.7(a) Civil Aircraft Airworthiness, Astraeus' request is based on the fact that no airworthiness certificate will be issued for the UAS. As previously noted, the petitioner's UAS will not require an airworthiness certificate in accordance with 14 CFR part 21, Subpart H. Based on the fact that an airworthiness certificate will not be issued, exemption from § 91.7(a) is not necessary.

In accordance with the pertinent part of 14 CFR § 91.7(b), the PIC of the UAS is responsible for determining whether the aircraft is in condition for safe flight. The petitioner's manuals for maintenance and operations include safety checklists to be used prior to each flight.

Regarding the petitioner's requested relief from 14 CFR § 91.9(b)(2) Civil aircraft flight manual, marking, and placard requirements and § 91.203(a) and (b) Civil aircraft: Certifications required, the original intent of these regulations was to display an aircraft's airworthiness, certification, and registration documents so they would be easily available to inspectors and passengers. Based on the FAA Memorandum subject "Interpretation regarding whether certain required documents may be kept at an unmanned aircraft's control station,"

dated August 8, 2014, the requested relief from 14 CFR §§ 91.9(b)(2) and 91.203(a) and (b) is not necessary.

Regarding the petitioner's requested relief from 14 CFR § 91.103 Preflight action, although there will be no approved Airplane or Rotorcraft Flight Manual as specified in paragraph (b)(1), the FAA believes that the petitioner can comply with the other applicable requirements in 14 CFR § 91.103(b)(2). The procedures outlined in the petitioner's MPTOM and FOPM address the FAA's concerns regarding compliance with § 91.103(b). The petitioner has also stated its intent to comply with § 91.103(a): "The PIC will take all actions including reviewing weather, flight battery requirements, landing and takeoff distances and aircraft performance data before initiation of flight." The FAA has imposed stricter requirements with regard to visibility and distance from clouds; this is to both keep the UA from departing VLOS and to preclude the UA from operating so close to a cloud as to create a hazard to other aircraft operating in the NAS. The FAA also notes the risks associated with sun glare; the FAA believes that the PIC's and VO's ability to still see other air traffic, combined with the PIC's ability to initiate a return-to-home sequence, are sufficient mitigations in this respect. The PIC will also account for all relevant site-specific conditions in their preflight procedures. Therefore, the FAA finds that exemption from 14 CFR § 91.103 is not necessary.

Regarding the petitioner's requested relief from 14 CFR § 91.109 Flight instruction; Simulated instrument flight and certain flight tests, the petitioner did not describe training scenarios in which a dual set of controls would be utilized or required, i.e. dual flight instruction, provided by a flight instructor or other company-designated individual, that would require that individual to have fully functioning dual controls. Rather, Astraeus evaluates the qualification of its PICs based on their experience with the UAS to be operated and verifies through testing, in lieu of formalized training. As such, the FAA finds that the petitioner can conduct its operations without the requested relief from 14 CFR § 91.109.

Regarding the petitioner's requested relief from 14 CFR § 91.119 Minimum safe altitudes, the petitioner failed to specify the pertinent part of 14 CFR § 91.119 from which they require relief. Relief from 14 CFR § 91.119(a) , which requires operating at an altitude that allows a safe emergency landing if a power unit fails, is unprecedented and unwarranted. Relief from § 14 CFR 91.119(b), operation over congested areas, is not applicable, because the petitioner states that operations will only be conducted within the sterile area described in the MPTOM.

Although the petitioner specifically mentioned relief from 14 CFR § 91.119(d), the FAA finds that relief is only needed from 14 CFR § 91.119(c), which is consistent with the relief typically provided to manned operations in FAA Order 8900.1 V3, C8, S1 Issue a Certificate of Waiver for Motion Picture and Television Filming. This Order allows for relief from § 91.119(c) with respect to those participating persons, vehicles, and structures directly involved in the performance of the actual filming. In accordance with the petitioner's stated intention to adhere to Order 8900.1 V3, C8, S1, persons other than participating persons[1] are not allowed

[1] Per Order 8900.1 V3, C8, S1, participating persons are all persons associated with the filming production, and they must be briefed on the potential risk of the proposed flight operation(s) and must acknowledge and accept those risks. Nonparticipating persons are the public, spectators, media, etc., not associated with the filming production.

within 500 feet of the operating area. This provision may be reduced to no less than 200 feet if an equivalent level of safety can be achieved and the Administrator has approved it. For example, an equivalent level of safety may be determined through evaluation by an aviation safety inspector of the filming production area to note terrain features, obstructions, buildings, etc. Such barriers may protect nonparticipating persons (observers, the public, news media, etc.) from debris in the event of an accident.

The FAA notes the petitioner's additional guidelines in its MPTOM to protect its participating production personnel, and finds that relief from 14 CFR § 91.119(c) is warranted, provided adherence to the procedures outlined in the petitioner's MPTOM and FOPM, and the FAA's additional conditions and limitations outlined below. However, all nonparticipating personnel will be required to be at least 500 feet from flight operations, with possible relief to allow reductions to 200 feet, as specified above.

Regarding the petitioner's requested relief from 14 CFR § 91.121 *Altimeter Settings*, the FAA believes that an altitude reading is a critical safety component of the petitioner's proposed operation. Although the petitioner will not have a typical barometric altimeter onboard the aircraft, the FAA finds the petitioner's intention to operate the UA within VLOS and at or below 400 feet AGL, combined with the petitioner's intention to provide altitude information to the UAS pilot via a digitally encoded telemetric data feed, which downlinks from the aircraft to a ground-based on-screen display, to be a sufficient method for ensuring the UAS operations do not adversely affect safety. The altitude information will be generated by equipment installed onboard the aircraft, as specified using GPS triangulation, or digitally encoded barometric altimeter, or radio altimeter, or any combination thereof. Prior to each flight, a zero altitude initiation point will be established and confirmed for accuracy by the UAS PIC. The FAA has determined that good cause exists for granting the requested relief to 14 CFR § 91.121.

Regarding the petitioner's requested relief from 14 CFR § 91.151(a) Fuel requirements for flight in VFR conditions, relief has been granted for manned aircraft to operate at less than the minimums prescribed in 14 CFR § 91.151(a), including Exemption Nos. 2689, 5745, and 10650. In addition, similar UAS-specific relief has been granted in Exemption Nos. 8811, 10808, and 10673 for daytime, Visual Flight Rules (VFR) conditions. The petitioner states that its UAS operations will be conducted in a controlled closed-set filming environment, with UA under 55 pounds, at speeds below 50 Knots, and within VLOS. These factors, combined with Astraeus' stated intention to terminate flights after 30 minutes or with 25% remaining battery power (whichever occurs first), provides the FAA sufficient reason to grant the relief from 14 CFR § 91.151(a) as requested in accordance with the conditions and limitations proposed by Astraeus.

With respect to the petitioner's request to operate at night, the FAA finds that the petitioner has not provided a sufficient safety case and mitigations, per FAA Order 8900.1 V16, C5, S3 General Operational Requirements, to avoid collision hazards at night. All previous UAS-specific grants of relief from 14 CFR § 91.151(a) have restricted flights to daytime VFR conditions only. While the FAA acknowledges the petitioner's stated film set lighting techniques to mitigate the risks of nighttime operations, the petitioner has not provided

sufficient data and analysis regarding the PICs' and VOs' ability to maintain VLOS with the UA and conduct their functions to see and avoid other potential obstacles and air traffic, relative to the lighting configuration on the film set. There is a limitation outlined below that precludes nighttime UAS operations. The petitioner may provide additional data and seek an amendment to its exemption to permit night operations.

Additionally, in evaluating the petitioner's proposed operating parameters with regard to VLOS and a safe operating perimeter, the FAA considered operations from a moving device or vehicle. Since the petitioner did not discuss provisions for these circumstances, the conditions and limitations below preclude operations from moving devices or vehicles.

Public Interest

The FAA finds that a grant of exemption is in the public interest. The enhanced safety achieved using a UA with the specifications described by the petitioner and carrying no passengers or crew, rather than a manned aircraft of significantly greater proportions, carrying crew in addition to flammable fuel, gives the FAA good cause to find that the UAS operation enabled by this exemption is in the public interest. The FAA also finds that UAS provide an additional tool for the filmmaking industry, adding a greater degree of flexibility, which supplements the current capabilities offered by manned aircraft.

The table below summarizes the FAA's determinations regarding the relief sought by the petitioner:

Relief sought by petitioner (14 CFR)	**FAA determination (14 CFR)**
Part 21	Not necessary
45.23(b)	Not necessary
61.113(a) and (b)	Granted with conditions and limitations
91.7(a)	Not necessary
91.9(b)(2)	Not necessary
91.103	Not necessary with conditions and limitations
91.109	Not necessary
91.119	Paragraph (c) granted with conditions and limitations
91.121	Granted with conditions and limitations
91.151(a)	91.151(a)(1), day, granted with conditions and limitations; 91.151(a)(2), night, denied
91.203(a) and (b)	Not necessary
91.405(a)	Granted with conditions and limitations
91.407(a)(1)	Granted with conditions and limitations

91.409(a)(2)	Granted with conditions and limitations; relief from 91.409(a)(1) also granted with conditions and limitations
91.417(a) and (b)	Granted with conditions and limitations

The FAA's Decision

In consideration of the foregoing, I find that a grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. §§ 106(f), 40113, and 44701, delegated to me by the Administrator, Astraeus Aerial is granted an exemption from 14 CFR §§ 61.113(a) and (b); 91.119(c); 91.121; 91.151(a); 91.405(a); 91.407(a)(1); 91.409(a)(1) and (2); and 91.417(a) and (b) to the extent necessary to allow Astraeus to operate unmanned aircraft systems (UAS) for the purpose of scripted, closed-set filming for the motion picture and television industry. This exemption is subject to the conditions and limitations listed below.

Conditions and Limitations

Relative to this grant of exemption, Astraeus is hereafter referred to as the operator.

The Flight Operations and Procedures Manual (FOPM) and Motion Picture and Television Operations Manual (MPTOM) are hereafter collectively referred to as the operator's manual.

Failure to comply with any of the conditions and limitations of this grant of exemption will be grounds for the immediate suspension or rescission of this exemption.

The operator proposed the following conditions and/or limitations, which were accepted by the FAA.[2]

1. The unmanned aircraft (UA) must weigh less than 55 pounds (25 Kg), including energy source(s) and equipment. Operations authorized by this grant of exemption are limited to the following aircraft described in the operator's manual: Astraeus Aerial Cinema System V.3CS UAS aircraft variant, serial #001 onward (V.3). Proposed operations of any other aircraft will require a new petition or a petition to amend this grant.

2. The UA may not be flown at a ground speed exceeding 50 knots.

3. Flights must be operated at an altitude of no more than 400 feet above ground level (AGL), as indicated by the procedures specified in the operator's manual. All altitudes reported to ATC must be in feet AGL.

[2] Conditions and limitations outlined by the operator may have been modified for clarity.

4. The UA must be operated within visual line of sight (VLOS) of the PIC at all times. This requires the PIC to be able to use human vision unaided by any device other than corrective lenses, as specified on the PIC's FAA-issued medical certificate.

5. All operations must utilize a visual observer (VO). The VO may be used to satisfy the VLOS requirement as long as the PIC always maintains VLOS capability. The VO and PIC must be able to communicate verbally at all times.

6. The operator's manual is considered acceptable to the FAA, provided the additional requirements identified in these conditions and limitations are added or amended. The operator's manual and this grant of exemption must be maintained and made available to the Administrator upon request. If a discrepancy exists between the conditions and limitations in this exemption and the procedures outlined in the operator's manual, the conditions and limitations herein take precedence and must be followed. Otherwise, the operator must follow the procedures as outlined in its operator's manual.

   The operator may update or revise its operator's manual. It is the operator's responsibility to track such revisions and present updated and revised documents to the Administrator upon request. The operator must also present updated and revised documents if it petitions for extension or amendment. If the operator determines that any update or revision would affect the basis for which the FAA granted this exemption, then the operator must petition for amendment to their exemption. The FAA's UAS Integration Office (AFS-80) may be contacted if questions arise regarding updates or revisions to the operator's manual.

7. Prior to each flight the PIC must inspect the UAS to ensure it is in a condition for safe flight. If the inspection reveals a condition that affects the safe operation of the UAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the UAS is found to be in a condition for safe flight. The Ground Control Station, if utilized, must be included in the preflight inspection. All maintenance and alterations must be properly documented in the aircraft records.

8. Any UAS that has undergone maintenance or alterations that affect the UAS operation or flight characteristics, e.g. replacement of a flight critical component, must undergo a functional test flight in accordance with the operator's manual. The PIC who conducts the functional test flight must make an entry in the UAS aircraft records of the flight. The requirements and procedures for a functional test flight and aircraft record entry must be added to the operator's manual.

9. The operator must follow the manufacturer's UAS aircraft/component, maintenance, overhaul, replacement, inspection, and life limit requirements. When unavailable, aircraft maintenance/component/overhaul, replacement, and inspection/maintenance requirements must be established and identified in the operator's manual. At a minimum, requirements for the following must be included in the operator's manual:

a. Actuators / Servos;

b. Transmission (single rotor);

c. Powerplant (motors);

d. Propellers;

e. Electronic speed controller;

f. Batteries;

g. Mechanical dynamic components (single rotor);

h. Remote command and control;

i. Ground control station (if used); and

j. Any other components as determined by the operator;

10. The Pilot In Command (PIC) must possess at least a private pilot certificate and at least a current third-class medical certificate. The PIC must also meet the flight review requirements specified in 14 CFR § 61.56 in an aircraft in which the PIC is rated on his or her pilot certificate.

11. Prior to operations conducted for the purpose of motion picture filming (or similar operations), the PIC must have accumulated and logged, in a manner consistent with 14 CFR § 61.51(b), a minimum of 200 flight cycles and 25 hours of total time as a UAS rotorcraft pilot and at least ten hours logged as a UAS pilot with a similar UAS type (single blade or multirotor). Prior documented flight experience that was obtained in compliance with applicable regulations may satisfy this requirement. Training, proficiency, and experience-building flights can also be conducted under this grant of exemption to accomplish the required flight cycles and flight time. During training, proficiency, and experience-building flights, all persons not essential for flight operations are considered nonparticipants, and the PIC must operate the UA with appropriate distance from nonparticipants in accordance with 14 CFR § 91.119.

12. Prior to operations conducted for the purpose of motion picture filming (or similar operations), the PIC must have accumulated and logged, in a manner consistent with 14 CFR § 61.51(b), a minimum of five hours as UAS pilot operating the make and model of UAS to be utilized for operations under the exemption and three take-offs and three landings in the preceding 90 days. Training, proficiency, experience-building, and take-off and landing currency flights can be conducted under this grant of exemption to accomplish

the required flight time and 90 day currency. During training, proficiency, experience-building, and take-off and landing currency flights all persons not essential for flight operations are considered nonparticipants, and the PIC must operate the UA with appropriate distance from nonparticipants in accordance with 14 CFR § 91.119.

13. Prior to any flight operations authorized by this grant of exemption, the PIC and VO must have successfully completed a qualification process, as outlined in the operator's manual. As this is a requirement stipulated by the operator, the test must be developed and implemented by a qualified person designated at the sole discretion of the operator. A record of completion of this qualification process must be documented and made available to the Administrator upon request.

14. Prior to operations conducted for the purpose of motion picture filming (or similar operations), a flight demonstration, administered by an operator-approved and -qualified pilot must be successfully completed and documented. This documentation must be available for review upon request by the Administrator. Because the knowledge and airmanship test qualifications have been developed by the operator, and there are no established practical test standards that support a jurisdictional FAA FSDO evaluation and approval of company designated examiners, the petitioner will conduct these tests in accordance with the operator's manual.

15. The UA may not be operated directly over any person, except authorized and consenting production personnel, below an altitude that is hazardous to persons or property on the surface in the event of a UAS failure or emergency.

16. Regarding the distance from participating persons, the operator's manual has safety mitigations for authorized and consenting production personnel. At all times, those persons must be essential to the closed-set film operations. Because these procedures are specific to participating persons, no further FSDO or aviation safety inspector approval is necessary for reductions to the distances specified in the petitioner's manuals. This is consistent with the manned aircraft procedures described in FAA Order 8900.1, V3, C8, S1 Issue a Certificate of Waiver for Motion Picture and Television Filming.

17. Regarding distance from nonparticipating persons, the operator must ensure that no persons are allowed within 500 feet of the area except those consenting to be involved and necessary for the filming production. This provision may be reduced to no less than 200 feet if it would not adversely affect safety and the Administrator has approved it. For example, an equivalent level of safety may be determined by an aviation safety inspector's evaluation of the filming production area to note terrain features, obstructions, buildings, safety barriers, etc. Such barriers may protect nonparticipating persons (observers, the public, news media, etc.) from debris in the event of an accident. This is also consistent with the same FAA Order 8900.1, V3, C8, S1.

18. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the security perimeter and land or be recovered in accordance with the operator's manual.

19. The UAS must abort the flight in the event of unpredicted obstacles or emergencies in accordance with the operator's manual.

20. Each UAS operation must be completed within 30 minutes flight time or with 25% battery power remaining, whichever occurs first.

In addition to the conditions and limitations proposed by the operator, the FAA has determined that any operations conducted under this grant of exemption must be done pursuant to the following conditions and limitations:

21. The operator must obtain an Air Traffic Organization (ATO) issued Certificate of Waiver or Authorization (COA) prior to conducting any operations under this grant of exemption. This COA will also require the operator to request a Notice to Airman (NOTAM) not more than 72 hours in advance, but not less than 48 hours prior to the operation.

22. All aircraft operated in accordance with this exemption must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification (N-Number) markings in accordance with 14 CFR part 45, Subpart C. Markings must be as large as practicable.

23. The operator must develop procedures to document and maintain a record of the UAS maintenance, preventative maintenance, alterations, status of replacement/overhaul component parts, and the total time in service of the UAS. These procedures must be added to the operator's manual.

24. Each UAS operated under this exemption must comply with all manufacturer Safety Bulletins.

25. The operator must develop UAS technician qualification criteria. These criteria must be added to the operator's manual.

26. The preflight inspection section in the operator's manual must be amended to include the following requirement: The preflight inspection must account for all discrepancies, i.e. inoperable components, items, or equipment, not covered in the relevant preflight inspection sections of the operator's manual.

27. Before conducting operations, the radio frequency spectrum used for operation and control of the UA must comply with the Federal Communications Commission (FCC) or other appropriate government oversight agency requirements.

28. At least three days before scheduled filming, the operator of the UAS affected by this exemption must submit a written Plan of Activities to the local FSDO with jurisdiction over the area of proposed filming. The 3-day notification may be waived with the concurrence of the FSDO. The plan of activities must include at least the following:

    a. Dates and times for all flights;

    b. Name and phone number of the operator for the UAS filming production conducted under this grant of exemption;

    c. Name and phone number of the person responsible for the on-scene operation of the UAS;

    d. Make, model, and serial or N-number of UAS to be used;

    e. Name and certificate number of UAS PICs involved in the filming production event;

    f. A statement that the operator has obtained permission from property owners and/or local officials to conduct the filming production event; the list of those who gave permission must be made available to the inspector upon request;

    g. Signature of exemption-holder or representative; and

    h. A description of the flight activity, including maps or diagrams of any area, city, town, county, and/or state over which filming will be conducted and the altitudes essential to accomplish the operation.

29. The documents required under 14 CFR §§ 91.9 and 91.203 must be available to the PIC at the Ground Control Station of the UAS any time the aircraft is operating. These documents must be made available to the Administrator or any law enforcement official upon request.

30. The UA must remain clear and yield the right of way to all other manned operations and activities at all times (including, but not limited to, ultralight vehicles, parachute activities, parasailing activities, hang gliders, etc.).

31. UAS operations may not be conducted during night, as defined in 14 CFR § 1.1. All operations must be conducted under visual meteorological conditions (VMC). Flights under special visual flight rules (SVFR) are not authorized.

32. The UAS may not be operated by the PIC from any moving device or vehicle.

33. The UA may not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the PIC.

34. The UA may not operate in Class B, C, or D airspace without written approval from the FAA. The UA may not operate within 5 nautical miles of the geographic center of a non-towered airport as denoted on a current FAA-published aeronautical chart unless a letter of agreement with that airport's management is obtained, and the operation is conducted in accordance with a NOTAM as required by the operator's COA. The letter of agreement with the airport management must be made available to the Administrator upon request.

35. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported to the FAA's UAS Integration Office (AFS-80) within 24 hours. Accidents must be reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.ntsb.gov. Further flight operations may not be conducted until the incident, accident, or transgression is reviewed by AFS-80 and authorization to resume operations is provided.

Unless otherwise specified in this grant of exemption, the UAS, the UAS PIC, and the UAS operations must comply with all applicable parts of 14 CFR including, but not limited to, parts 45, 47, 61, and 91.

This exemption terminates on September 30, 2016, unless sooner superseded or rescinded.

Issued in Washington, DC, on September 25, 2014. .

/s/
Michael J. Zenkovich
Deputy Director, Flight Standards Service